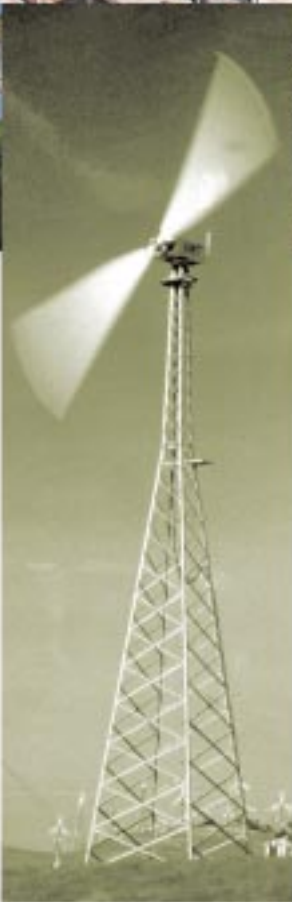




THE CALIFORNIA ENERGY COMMISSION'S

1998 Annual Report

Concerning The Public Interest Energy Research Program



Gray Davis, Governor
March 1999

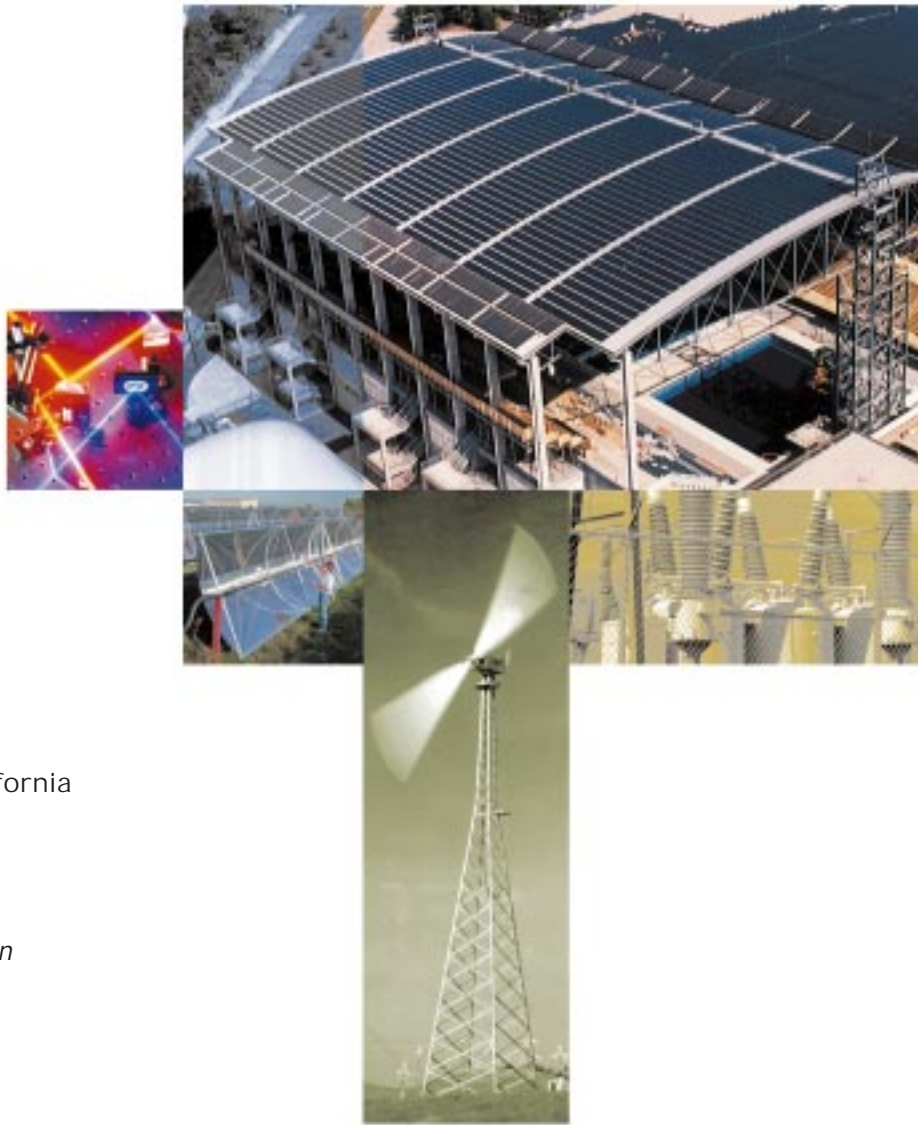
P500-99-004



THE CALIFORNIA ENERGY COMMISSION'S

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Concerning The Public Interest Energy Research Program



State of California
Gray Davis, *Governor*

The Resources Agency of California
Mary Nichols, *Secretary*

California Energy Commission
William J. Keese, *Chairman*
David A. Rohy, Ph.D., *Vice Chairman*
Robert A. Laurie, *Commissioner*
Michal C. Moore, *Commissioner*
Jananne Sharpless, *Commissioner*

P500-99-004



CALIFORNIA ENERGY COMMISSION

March 17, 1999

Members of the Senate Energy, Utilities and Communications Committee
Members of the Senate Budget and Fiscal Review Committee
Members of the Senate Appropriations Committee
Members of the Assembly Utilities and Commerce Committee
Members of the Assembly Budget Committee
Members of the Assembly Appropriations Committee
California State Capitol Building
Sacramento, California 95814

Re: The California Energy Commission's 1998 Annual Report Concerning the Public Interest Energy Research Program

Dear Members:

In accordance with Public Resources Code Section 25620.8, the California Energy Commission hereby transmits its first Annual Report to the Legislature concerning the Public Interest Energy Research (PIER) Program, for the period January 1 through December 31, 1998. This Annual Report provides the following information: (1) a brief background and overview of the program; (2) a current status of the program, including all funding awards made by the Commission as of December 31, 1998; and (3) the Commission's recommended future direction for the PIER Program. The report specifically includes all required information on the "names of award recipients, the amount of awards, the types of projects funded...and recommendations for improvements in the program." However, since the projects funded during the first year of the PIER Program are multi-year projects which are not yet complete, the required annual "evaluation of the success of any funded projects" will be provided in subsequent Quarterly and Annual Reports on the PIER Program.

As reflected in this Annual Report, the Energy Commission has made substantial progress in implementing the PIER Program to date. California's success with the PIER Program serves as a model for other states and has become a focal point for an Energy Commission/Department of Energy Memorandum of Understanding. Both the New York State Energy Research Development Authority and the Association of State Energy Research and Technology Transfer Institutions are pursuing similar avenues. Should you have questions or comments concerning this report, please feel free to contact Traci Stevens, Energy Commission Director of Governmental Affairs, at 654-4942.

Respectfully submitted,

WILLIAM J. KEESE, Chairman of the
California Energy Commission

DAVID A. ROHY, PH.D., Vice Chair and
Presiding Member of the RD&D
Committee

cc: California Legislative Analyst's Office

ACKNOWLEDGEMENTS

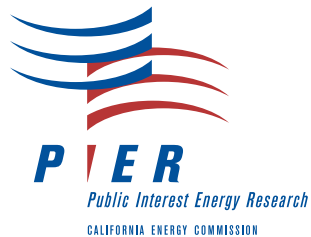
The California Energy Commission wishes to acknowledge the invaluable contributions made to the PIER Program by the Commission's staff, the members of the PIER Policy Advisory Council, and the many concerned citizens who have actively participated in PIER-related advisory groups, planning focus groups, and other program forums to date. This participation has provided essential input throughout the program's first year of development, and the Commission will continue to seek such input and assistance in the future as it strives to further develop and improve the PIER Program. The Commission also wishes to acknowledge the outstanding individuals who have recently agreed to serve on the Independent PIER Evaluation Panel authorized by the Legislature. Finally, the Commission wishes to acknowledge the many highly talented and creative researchers and research organizations who are participating in the PIER Program. Without the team effort of these various dedicated participants, the important public benefits of the PIER Program could not be achieved.

A complete list of the following PIER Program participants appears in the Appendix to this 1998 Annual PIER Report:

- Energy Commission Staff Contributors
- PIER Policy Advisory Council Members
- Independent PIER Evaluation Panel Members

*Cover photos courtesy
of NREL PIX*

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Appendices of PIER Projects and Other Information

SUMMARY**I. Background Regarding the PIER Program**

Before the restructuring of California's electricity industry in 1996, ratepayer-funded energy-related research, development and demonstration (RD&D) projects were primarily conducted by the state's regulated utilities, and energy-related public interest RD&D was a key component of the rate structure mandated by the California Public Utilities Commission (CPUC) for the investor-owned utilities (IOUs). During this period, California led the nation in developing and deploying a wide range of innovative energy technologies and services that were environmentally sound and saved ratepayers billions of dollars through improved generation and/or end-use efficiencies.

In 1996, California significantly restructured the electricity services industry in this state through the enactment of Assembly Bill (AB) 1890. In AB 1890 the Legislature expressly determined that those RD&D activities which serve a broader public interest "should not be lost in the transition to a more competitive environment." To ensure continued funding for energy-related public interest RD&D, the Legislature authorized the collection of a non-bypassable surcharge on the retail sale of electricity of at least \$62.5 million annually to provide for these "public goods" efforts.

Recognizing the California Energy Commission's longstanding and widely acknowledged leadership role in energy-related RD&D activities, the Legislature further

directed the CPUC to transfer to the Energy Commission specified surcharge funds for this public interest energy research (PIER) program. In accordance with these directives, in 1997 the CPUC determined that from January 1, 1998 through December 31, 2001, at least \$61.8 million annually will be transferred to the Energy Commission's PIER Program Trust Account. These funds will be used to support those public interest RD&D activities that would not otherwise be adequately funded by the competitive or regulated markets.

To effectively implement its responsibilities for public interest research, the Energy Commission determined that an RD&D Strategic Plan should be developed for the PIER Program. After conducting a series of statewide collaborative public hearings and workshops to gather input from various stakeholders and interest groups, the Commission adopted its RD&D Strategic Plan in 1997. This provided the framework for one of the nation's leading public interest energy research programs, and other states are now actively looking at the PIER Program as a model for continuing public interest research in a restructured electric services industry.

In October of 1997 Senate Bill 90 (Sher, Chapter 905) was enacted into law. This legislation further defined the PIER Program by identifying the key

subject areas for funding and by providing specific administrative and expenditure criteria for the PIER Program.

II. Current Status of the PIER Program

A. Policy and Planning

AB 1890, SB 90 and the Commission's RD&D Strategic Plan set forth the key policies and public benefits which the PIER Program is intended to provide. The mission of the PIER Program is to conduct public interest energy research that seeks to improve the quality of life for California's citizens by providing "environmentally sound, safe, reliable and affordable energy services and products." Funding is restricted by law to those public interest RD&D projects which the Commission determines "are not adequately provided for by competitive or regulated markets." In addition, the Commission is required to develop a "balanced portfolio... [of RD&D projects that includes] the relevant core subject areas of environmental enhancements, end-use efficiency, environmentally-preferred advanced generation technologies, renewable technologies, and other strategic energy research, including public interest system reliability... not adequately addressed by the Public Utilities Commission." Thus, the Commission is responsible for ensuring that energy-related public interest research will continue in a deregulated energy environment.

In 1998, the Commission established six talented interdivisional teams led by staff experts for each of the PIER Program areas listed above. (Note: Because of the broad nature of the end-use energy efficiency subject area, the Commission decided to disaggregate this particular PIER Program subject area into two separate subprogram areas of "Buildings" and "Industrial/Agricultural/Water" end-use energy efficiency.) Each team is responsible for planning and implementing the RD&D activities needed to

meet specific PIER goals and deliver results in the program areas in question.

B. Projects Funded in 1998

In 1998, the Energy Commission awarded approximately \$56 million in PIER funds to 83 outstanding energy research projects and two important energy research programs. Specifically, the Commission successfully completed three competitive solicitations which provided approximately \$49 million in PIER funds for 83 projects in five identified subject areas. In addition, in 1998 the Commission entered into two Interagency Agreements and one sole-source contract which provided approximately \$7 million for other important energy-related public interest research efforts. All of the projects and programs funded in 1998 address the mission and objectives of the PIER Program as set forth in AB 1890, SB 90, and the Commission's RD&D Strategic Plan.

1. Individual PIER Project Awards

In 1998, three competitive funding solicitations were completed and approximately \$49 million in PIER funds were awarded to 83 individual projects. These competitive awards will leverage approximately \$71 million in matching funds and other in-kind contributions, and nearly 40 percent of these competitive awards went to small businesses.

Specifically, the Commission awarded approximately \$17 million to 39 separate "transition" RD&D projects covering the five PIER subject areas. These projects are expected to preserve the benefits of the most promising ongoing public interest RD&D efforts conducted by investor-owned utilities, under the CPUC's oversight, prior to the onset of electricity restructuring.

The *First General Solicitation* sought projects in the areas of renewable energy generation, environmentally preferred advanced generation, and energy-related

environmental research. Approximately \$18.3 million was awarded to the 20 projects that were selected for funding.

The *Second General Solicitation* sought projects in the areas of end-use energy efficiency and strategic energy research. Approximately \$13.6 million was awarded to the 24 projects that were selected for funding.

Each of these 83 projects is described in further detail in Appendix A.

2. Energy Innovations Small Grants Program

In 1998, the Commission developed an Energy Innovations Small Grants Program to assist certain innovative “proof of concept” research efforts that might not otherwise be able to obtain PIER funding. The maximum amount of any individual grant will be \$75,000, and total funding for this program is limited to \$5 million over the next two years. The primary responsibility for administering this program has been assigned through an Interagency Agreement to the California State University Institute, but the Commission retains oversight and final approval for all funding awards.

3. Electric Power Research Institute Program

In 1998, the Commission also approved a one-year trial membership with the Electric Power Research Institute (EPRI) in order to allow the Commission to participate in the nationally funded electricity RD&D efforts which EPRI conducts. The \$1.5 million membership fee will help fund seven public interest programs in energy efficiency, distributed generation and system reliability. This PIER-funded membership will leverage \$12 million in matching funds from other EPRI members.

C. PIER Program Administration

An important objective in the Commission’s RD&D Strategic Plan is to ensure that the PIER Program is administered in an efficient and effective manner. In 1998, the Commission successfully undertook several important steps to ensure that this objective is achieved through internal reorganization and contract streamlining. In addition, the Commission successfully sought ways to streamline its existing contract reporting, invoicing and auditing procedures.

Public Resources Code Section 25620.9(a) directed the Energy Commission (by January 1, 1999) to designate a panel of independent experts to conduct a comprehensive evaluation of the PIER Program. The panel is required to submit its preliminary PIER evaluation report to the Governor and the Legislature by March 31, 2000, and a final report (including additional findings and recommendations) is due by March 31, 2001. In 1998, following extensive statewide and national contacts, the Energy Commission designated nine respected individuals to serve on the Independent PIER Evaluation Panel. The Commission added three additional members to the panel during the first quarter of 1999. The panel held its first meeting on February 8, 1999.

The Commission has completed and timely-filed with the Legislature all statutorily-required PIER Quarterly Reports and this 1998 PIER Annual Report.

III. Future Program Directions

In 1999, the Commission intends to build on its successful launch of the PIER Program and to maximize the public value of the program by 1) more sharply focusing future PIER funding awards on those areas of public interest energy research that are of the highest priority and greatest

benefit to California's citizens; 2) increasing the "purchasing power" of available PIER funds by selectively entering into major co-funded RD&D efforts with the federal government and with other states; 3) improving the PIER project-selection process by adding a new "competitive negotiation" method to current selection methods; 4) carefully and efficiently managing all existing PIER contracts to ensure that ratepayer funds are well spent and that maximum public value is obtained from these contracts; and 5) actively initiating steps to effectively transfer into the market the results of the various PIER-funded RD&D efforts.

IV. Conclusion

1998 was an exciting, challenging and successful commencement year for the PIER Program. The Energy Commission fully expects that this program will continue to provide significant public benefits in the years ahead and will continue to serve as a leading model for public interest energy research throughout the nation and the world.



Photo credit: Flowind Corporation, courtesy of NREL PIX

I. Overview of the PIER Program

A. Background

In 1996, California adopted far-reaching legislation which deregulated much of this state's electric services industry (1996 Statutes, Chapter 854, hereinafter "AB 1890"). Article 7 of AB 1890 was enacted to ensure that the benefits obtained from important public purpose programs, such as public interest research, development and demonstration (RD&D), would not be lost in the newly deregulated environment. As a result, Public Utilities Code Section 381 now requires that, starting on January 1, 1998, at least \$62.5 million will be collected annually through California's electric investor-owned utilities (IOUs) to fund energy-related public interest RD&D activities *"not adequately addressed by competitive and regulated markets."*

The California Energy Commission is authorized in AB 1890 to receive and administer such funds as designated by the California Public Utilities Commission (CPUC) for the conduct of public interest RD&D, subject to administration and expenditure criteria established by the Legislature. In 1997, the CPUC determined that at least \$61.8 million annually should be transferred from the major IOUs to the Energy Commission for specified public interest energy research (D.97-02-014).¹ These funds are subject to the

administrative and expenditure criteria adopted by the Legislature in 1997 (1997 Statutes, Chapter 905, hereinafter SB 90), which are contained in Public Resources Code Section 25620 *et seq.*

B. Developing A Strategic Plan for Public Interest Energy Research

Beginning in 1996, the Commission conducted an extensive public process to collect input and recommendations from a wide variety of stakeholders and interested citizens on how to best administer the Public Interest Energy Research (PIER) Program authorized in AB 1890. An advisory group, consisting of more than 70 separate organizations and individuals concerned with public interest RD&D issues, held a series of public workshops throughout the state and provided detailed comments and recommendations to the Commission.

Based on this extensive public input, the Commission adopted a report entitled *"Strategic Plan For Implementing The RD&D Provisions Of AB 1890,"* (P 500-97-007, June 1997). This report includes a Mission Statement and Objectives for the PIER Program, as well as a strategic plan for administering the program. It will be updated and revised periodically, as needed, in the future.

¹ In 1998 a small IOU, Bear Valley Electric Company (also known as Southern California Water Company) sought and received CPUC authority to contribute \$56,000 annually to the PIER Program.

C. Mission Statement for the PIER Program

The Commission's RD&D Strategic Plan provides that:

The mission of the Public Interest Energy Research program is to conduct public interest energy research that seeks to improve the quality of life for California's citizens by providing environmentally sound, safe, reliable and affordable energy services and products. *Public Interest Energy Research* includes the full range of research, development and demonstration activities that will advance science or technology not adequately provided by competitive and regulated markets.

D. Objectives of the PIER Program

In order to achieve the goals set forth in the PIER Mission Statement, the Commission also adopted specific objectives for the PIER Program. These objectives are to:

1. Develop and implement a robust public interest RD&D portfolio of projects that addresses California's energy needs and initially focuses on end-use energy efficiency, environmentally preferred advanced generation, renewable energy technologies, and environmental issues. This portfolio shall also provide strategic energy research. The public interest portfolio would include public interest system reliability RD&D not covered by the CPUC.
2. Create and maintain a public interest RD&D program that balances risks, timeframes and public benefits in a manner consistent with California's energy policies.
3. Create a public interest RD&D knowledge base and disseminate information that will allow citizens, businesses, government and other entities to make informed decisions concerning energy technologies and services.
4. Ensure that the public interest RD&D program is connected to the market by (a) collaborating with market and public interest stakeholders to determine research and market needs during program planning; (b) incorporating the assessment and understanding of market needs and technology status into appropriate phases of RD&D projects; and/or (c) transferring public interest RD&D results into the marketplace through partnerships and other actions.
5. Ensure public input and accountability for the public interest RD&D program by (a) conducting an open and flexible planning and decision-making process which involves stakeholders in both planning and implementing the program; (b) using advisory committees and expert panels to guide programs and evaluate project proposals; and (c) using an independent group for periodic overall program review and evaluation.
6. Ensure the efficient administration and stewardship of public interest RD&D funds by (a) implementing a streamlined project acquisition and funding process; (b) using prescribed project evaluation criteria to select projects based on merit; (c) leveraging limited public interest RD&D funds through public/private partnerships to the extent possible; (d) managing projects flexibly and effectively; and (e) avoiding excessive overhead costs.
7. Provide leadership and coherence for California's public interest RD&D efforts by (a) coordinating with public and private RD&D entities and (b) integrating this effort with the Energy Efficiency/Renewables programs and other public interest energy efforts.

II. Current Status of the PIER Program

The current status of the various functions of the PIER Program, as of December 31, 1998, is set forth below.

A. Policy Development and Planning for the PIER Program

AB 1890, SB 90, and the Commission's RD&D Strategic Plan have identified the essential state policies for energy-related public interest research that are to be carried out through the PIER Program. In turn, the results from the PIER Program are expected to provide input for future state energy policies, with an emphasis on articulating the roles and benefits of public interest energy RD&D. This dynamic interaction between program results and overarching energy policies will ensure that the PIER Program remains vital and relevant to the ever-changing needs of this state.

In addition, in 1998 a highly respected Policy Advisory Council (PAC) was formed to provide ongoing advice to the Commission's RD&D Committee regarding the effective implementation of the PIER Program. The PAC is comprised of a group of high level representatives from industry, academia, research institutions and various stakeholder associations. A list of the members of the Policy Advisory Council is attached in the Appendix C.

The Commission's RD&D Strategic Plan recommends that planning efforts for the PIER Program be undertaken at levels corresponding to the program's organizational structure and funding areas. In 1998, the Commission established the following six PIER Program funding areas:

- Residential and Commercial Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research

Interdivisional teams led by staff experts have been formed for each of the six program areas listed above. Each team is responsible for planning and implementing the RD&D activities needed to meet specific PIER goals and deliver results in the program areas in question. As with all aspects of the PIER Program, this effort is conducted with review and input from the Policy Advisory Council, focus groups, stakeholders, and interested members of the public. Current and future program plans will be periodically reviewed and evaluated—both internally and externally—to recognize the changing roles and scope of the program.

B. Funding of Public Interest RD&D Projects in 1998

In 1998, the Energy Commission awarded approximately \$56 million in PIER funds to 83 outstanding public interest energy research projects and two important public interest energy research programs. These funding awards seek to provide public benefits in the following key areas of the PIER Program:

End-Use Energy Efficiency: The end-use energy efficiency efforts funded in 1998 seek to provide public benefits in areas such as conservation of natural resources, improved air quality, reduced expenditures on energy by consumers, and increased statewide and regional economic benefits.

Renewable Energy Technologies: The renewable energy technology efforts funded in 1998 seek to provide public benefits in areas such as energy diversity, improved environmental quality, improved management of natural resources through the use of indigenous energy resources, protection of public health and safety, and increased benefits to local and regional economies.

Environmentally Preferred Advanced Generation: The environmentally preferred advanced generation efforts funded in 1998 seek to provide public benefits in areas such as cost savings to energy consumers, improved environmental quality, and reduced fuel consumption.

Energy-Related Environmental Research: The energy-related environmental research efforts funded in 1998 seek to provide public benefits by improving scientific understanding and/or addressing the environmental effects and costs of energy production, delivery and use in California. In addition, some of the environmental research funds awarded in 1998 will be used to explore how new energy applications and products can assist in solving various environmental issues.

Strategic Energy Research: The strategic energy research efforts funded in 1998 seek to provide public benefits by improving electricity system reliability (concerning electricity supply, conversion, transfer or consumption), improving overall system efficiency, reducing system-wide environmental impacts, and improving products from and/or services for electricity customers. The strategic energy research area also seeks to ensure that electricity customers will have the tools needed to fully benefit from the deregulated energy market.

During 1998, the Energy Commission used several different procurement methods (three competitive solicitations, two interagency agreements, and one sole source contract) to identify and fund various public interest RD&D projects under the PIER Program. Additional details regarding these solicitations are provided below.

1. Individual Project Awards

As of December 31, 1998, the Commission had conducted and successfully completed three separate competitive solicitations through the PIER Program. These competitive solicitations carefully evaluated over 400 RD&D projects seeking public funds, and the top-ranked 83 projects were awarded approximately \$49 million in PIER funds in the six program areas listed below:

- Residential and Commercial Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Environmentally Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research

This \$49 million in competitive PIER awards will be matched with approximately \$71 million in other cash and in-kind matching funds, thus providing approximately \$120 million in total funding for these public interest energy research projects. An overall breakout of the types of projects funded and the types of entities receiving these PIER awards is contained in the attached charts.

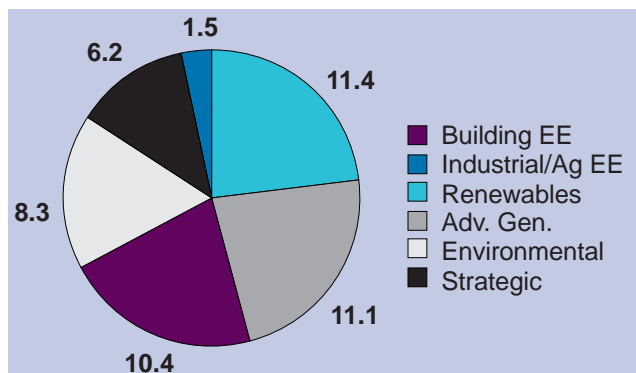
2. The Energy Innovations Small Grants Program

In 1998, the Commission awarded an Interagency Agreement of \$5 million in PIER funds to the California State University Institute for an Energy Innovations Small Grants Program which will assist inventors in conducting the important “proof of concept” stage of promising research.² Further information on this program is provided below.

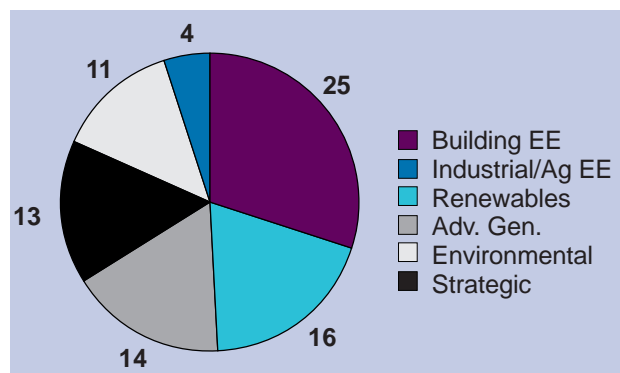
Before creating the Energy Innovations Small Grants Program in 1998, the Energy Commission identified two particular areas of concern regarding the traditional “competitive bid” process for obtaining funds from the PIER Program. The first concern was a lack of PIER funding support for the early “feasibility of concept” stage of RD&D relative to other critical milestones. The standard PIER competitive solicitation process assumes that the basic

² The Commission also provided approximately \$300,000 in Interagency PIER funding to the University of California for important ongoing public interest RD&D activities being conducted at the National Fuel Cell Research Center located on the U.C. Irvine campus.

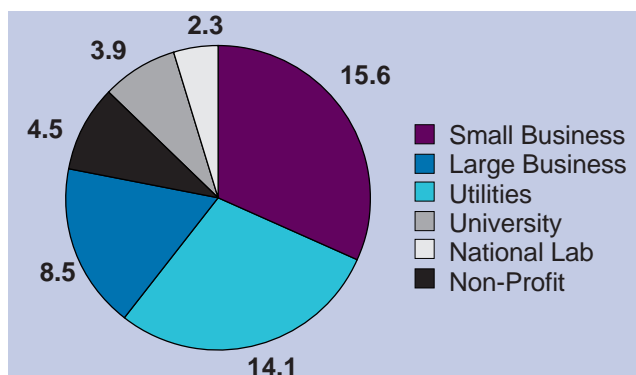
**1998 Funding by PIER Program Area
(\$\$Millions)**



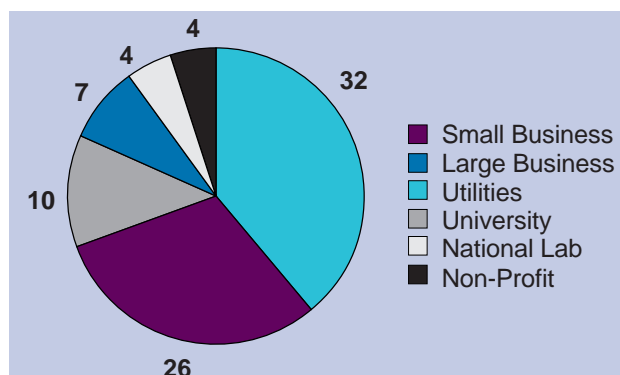
**Number of Projects by
PIER Program Area**



**Funding by Type of Research Organization
(\$\$Millions)**



**Number of Projects by
Type of Research Organizations**



technical and economic feasibility of the concept issues have been addressed prior to applying for PIER funds, and that PIER applicants are therefore ready to engage in applied research and development. Thus, if a researcher has not completed the “proof of concept” work, funding cannot be obtained through the traditional PIER competitive solicitation process.

The second area of concern was the relative difficulty that smaller, less well-funded groups in the RD&D community (such as small businesses, small non-profits, individuals and academic institutions) encounter when applying for PIER funds through the traditional competitive solicitation process.

The Energy Commission has determined that it is important to provide these types of inventors with a simplified, low-cost opportunity to develop their research and development concepts for the public benefit. Accordingly, in 1998 the Commission approved a two year, \$5 million Interagency Agreement with the California State University Institute (CSUI), delegating administrative responsibility to the California State University system for the Energy Innovations Small Grants program. CSUI will develop a simplified funding application process to identify and recommend worthy “proof of concept” projects to the Commission. The Commission, in turn, will participate

in the project review process and will also maintain final approval authority for any projects that are funded.

3. Electric Power Research Institute Membership

The Electric Power Research Institute (EPRI), based in Palo Alto, California, is a leading international energy research organization, funded primarily by electric utilities throughout the country. Historically, much of this funding has been collected from utility ratepayers for public interest research required by public utility commissions in each state. However, as a result of deregulation, many of California's electric utilities have eliminated their funding of public interest RD&D efforts, including their contributions to EPRI. The Energy Commission believes that continued funding for certain EPRI program area memberships may help to ensure that California continues to receive the benefits of these nationally funded electricity RD&D efforts. These project memberships will also allow the Commission to participate in guiding these national RD&D activities.

In September 1998, the Commission approved (with the Legislature's concurrence) a one year sole source contract for a trial membership with EPRI. This \$1.5 million membership will fund seven public interest projects in energy efficiency, distributed generation, and system reliability. The membership will leverage \$12 million in matching funds from other EPRI members.

The Energy Commission's PIER-funded EPRI membership is already providing public benefits, as exemplified by research in two areas essential to California's economy: petroleum production and agriculture. Petroleum production and agriculture are two of the largest electricity consumers in the state and EPRI's PIER-funded research seeks to reduce the overall costs associated with these activities. Public benefits obtained from these EPRI research efforts will include an increase in water availability, improved economics and reduced use of pesticides.

Specifically, one of the important EPRI research efforts concerning petroleum production is a pilot plant which uses electricity to make potable (drinking water) or agricultural (irrigation) water from contaminated water from oil wells. This project is expected to reduce the overall costs of dealing with contaminated water and to increase the amount of useable water available in California.

In the agricultural research area, EPRI's PIER-funded ozone fumigation project will deliver benefits to California through increased crop yields, reduced ozone depletion, and enhanced compliance with international agreements on pesticides. This particular project leverages funding from other EPRI members, to fumigate soil with electricity-derived ozone instead of the chemical methyl bromide, which is being phased out by international agreement. Crop yields show significant increase when soil is fumigated prior to planting. Benefits may also result from reduced use of irrigation water, reduced use of fertilizer, and increased crop yields.

C. Program Administration

1. Improving PIER Program Efficiency

An important objective in the Commission's RD&D Strategic Plan is to ensure that the PIER Program is administered in an efficient and effective manner. In 1998, the Commission undertook two important steps to achieve this objective, i.e. internal reorganization and contract streamlining.

Prior to the PIER Program, four line divisions within the Commission managed individual programs wholly within each division, and relied on the fifth division—Administrative Services—to provide support for contracts, grants, fiscal accounting and the like. However, the subject areas outlined in the RD&D Strategic Plan cut across all of the divisions at the Commission, making the existing organization and reporting structure ineffective and

inefficient. Therefore, in 1998 interdivisional teams were created to address issues and responsibilities in each of the six PIER Program planning areas. In addition, the interdivisional teams were expanded to include legal and contracting experts, and the primary responsibility for certain program areas was shifted to the division with the most expertise. This new administrative structure is dynamic and will evolve along with other aspects of the program.

In designing the PIER Program, the Commission conducted an extensive review of its RD&D contracting procedures to identify areas of needed improvement. Thereafter, a two-phased contracting reform effort was implemented to reduce the time and cost of contracting in the PIER Program. Phase I resulted in a package of specific statutory amendments enacted in 1997, through SB 90, to provide for contracting flexibility. Phase II streamlined various internal contracting policies and procedures at the Commission.

The Commission now uses customized contract terms and conditions which recognize relevant differences among client groups including universities, utilities, small business, large business, and national laboratories. These customized terms and conditions have dramatically reduced the time and effort required for executing contracts. In addition, a simplified invoicing process has been developed and is being used with all PIER contracts, and the requirements for extensive back-up information have been eliminated and replaced by an audit program conducted by the Department of Finance. Other efforts to further streamline the PIER contracting process are ongoing.

2. Designation of the Independent PIER Evaluation Panel

Public Resources Code Section 25620.9(a) required the Energy Commission (by January 1, 1999) to designate an independent panel of experts to conduct a comprehensive evaluation of the PIER Program for submittal to the Governor and Legislature. The

Independent Panel is required to submit its preliminary report to the Governor and the Legislature by March 31, 2000, and a final report (including additional findings and recommendations) is due by March 31, 2001.

In 1998, following extensive statewide and national contacts, the Energy Commission designated nine outstanding individuals to serve on the Independent Panel. The Commission has named three additional members to the panel during the first quarter of 1999. The panel held its first meeting on February 8, 1999. A list and summary description of the designated panel members are contained in the Appendix D to this report.

3. Timely Reporting On PIER Program Efforts

Public Resources Code Section 25620.5(h) requires the Commission to provide to the Legislature, on a quarterly basis, an "evaluation of the progress and a status of the [PIER Program's] implementation to date." In 1998, the Commission completed and filed each of these Quarterly Reports with the Legislature in a timely manner. Public Resources Code Section 25620.8 also requires the Commission report annually to the Legislature on the status of the PIER Program. This 1998 PIER Annual Report is being provided in a complete and timely manner.

4. 1998 Financial Statement for the PIER Program (January through December '98)

1998 Income:

Payments from Utilities	\$61,800,000.00
Interest Earnings ³	<u>\$ 1,667,287.00</u>
Total Income	\$63,467,287.00

1998 Expenditures

Program Awards ⁴	\$55,725,138.00
Program Administration ⁵	<u>\$ 2,165,302.00</u>
Total Expenditures	\$57,890,440.00

1998 Reserves \$ 5,576,847.00

(Available For Future Allocations)⁶

III. Future Program Directions

In 1998, the Energy Commission successfully launched the PIER Program by awarding approximately \$56 million to 83 energy-related RD&D projects, and two important energy-related programs, in the five subject areas identified in SB 90 and the Commission's RD&D Strategic Plan. As discussed elsewhere in this Annual Report, these funding awards were primarily conducted through three *non-targeted general competitive solicitations*, one sole-source contract with EPRI, and one interagency agreement to establish an Energy Innovations Small Grants program.

In 1999, the Commission intends to build on its successful launch of the PIER Program and maximize the value of the program by 1) more sharply focusing future PIER funding awards on those areas of public interest energy research that are of the highest priority and greatest benefit to California's citizens; 2) increasing the "purchasing power" of available PIER funds by selectively

entering into major co-funded RD&D efforts with the federal government and with other states; 3) improving the PIER project-selection process by adding a new "competitive negotiation" method to current selection methods; 4) carefully and efficiently managing all existing PIER contracts to ensure that ratepayer funds are well spent and that maximum public value is obtained from these contracts; and 5) actively initiating steps to effectively transfer into the market the results of the various PIER-funded RD&D efforts. Further detail regarding each of these "future directions" is set forth below.

Focusing Future Funding Awards

In 1998, the Commission undertook a number of steps to identify the public interest energy research areas of highest priority and value to California's citizens. Among other things, the Commission held numerous "focus groups" with representatives from all energy-related sectors of the state's economy; developed a reliable "decision making analysis" procedure for identifying and prioritizing key energy research issues; established interdivisional teams led by staff experts for each of the six key program areas listed above; and began the important process of selecting the main areas of focus for future PIER funding awards. In 1999, the Commission (in close consultation with its Policy Advisory Council and the public) will identify those areas of public interest energy research upon which future PIER funding awards will focus.

Coordinated Funding Efforts

In 1998, the Commission entered into an important Memorandum of Understanding (MOU) with the federal Department of Energy (DOE). Among other things, this

³ Interest earned in the State Pooled Money Investment Account in the State Treasury.

⁴ Amounts awarded by the Energy Commission for PIER projects and programs.

⁵ Energy Commission staffing, operating costs and technical support contracts.

⁶ The Commission encumbered 100% of the available PIER funds authorized for fiscal year 1997-1998. The "1998 reserves" reflect PIER funds that were authorized for fiscal year 1998-99 (with a two year encumbrance period) and were available as of Dec. 31, 1998.

MOU committed the Commission and DOE to a close working relationship intended to identify energy-related areas of mutual interest and high priority for future collaboration and co-funding. In 1999, the Commission intends to complete this process and enter into major co-funding efforts with the federal government and with other states, thereby providing maximum “purchasing power” and benefits to California from the PIER funds devoted to such co-funding efforts.

Competitive Negotiations

In SB 90 the Commission was given the statutory authority to engage in a “competitive negotiation” process when selecting projects for PIER funding awards. This process would allow the Commission to actually “negotiate” the details of competing proposals, rather than to be restricted to the “take it or leave it” process of traditional competitive solicitations. In 1998, the Commission developed the preliminary framework for such “competitive negotiations,” and in 1999 the Commission expects to award its first PIER funds using this new method. The effectiveness of this alternative means for contracting will then be evaluated, and decisions about its future use will be made.

Effective Management of Existing Contracts

In 1998, the Commission awarded approximately \$56 million in PIER funds to 83 separate energy RD&D projects and two key energy-related RD&D programs. In 1999, the Commission will need to carefully monitor the progress of these projects to ensure that funds are being well spent, and that maximum benefits from this portfolio of projects are obtained for the public. Progress reports regarding these RD&D efforts will be provided to the Legislature through the 1999 PIER Quarterly Reports and the next PIER Annual Report.

Technology Transfer Efforts

The Commission is keenly aware that RD&D efforts may be of little value if the results are not made known and/or effectively transferred into the market. In 1999, the Commission will undertake several steps to ensure that the results of the PIER funded RD&D efforts are effectively transferred into the market. Among other things, the Commission will maintain and continuously update its PIER-related Website to keep the current status of projects available to anyone who is interested. In addition, in the fall of 1999 the Commission will sponsor a major PIER-related symposium to facilitate the exchange of relevant information and ideas between researchers, technology users and other interested parties from throughout the state, nation, and international community.

IV. Conclusion

1998 was an exciting, challenging and successful commencement year for the PIER Program. The Energy Commission fully expects that this program will continue to provide significant public benefits in the years ahead, and will continue to serve as a leading model for public interest energy research throughout the nation and the world.



P I E R

Public Interest Energy Research

CALIFORNIA ENERGY COMMISSION

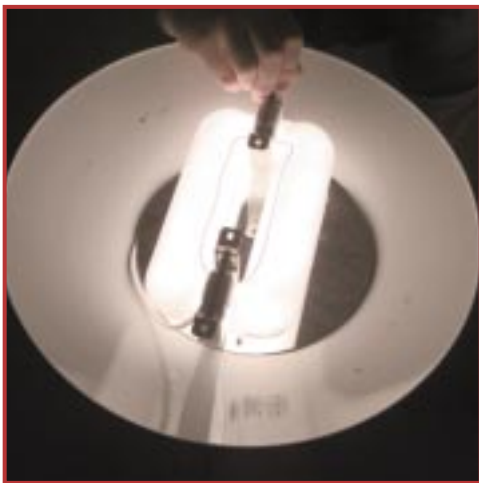
Residential and Commercial Buildings End-Use Energy Efficiency



Project Title: Commercial Thermal Distribution Systems

Pictured is the "Aeroseal" Duct Sealer developed by Lawrence Berkeley National Laboratory (LBNL) for the California Institute For Energy Efficiency (CIEE). This product is commercially available for use in residential applications. PIER program funds are being used to develop this duct sealing technology for large commercial building applications. Duct coating technology is also being researched.

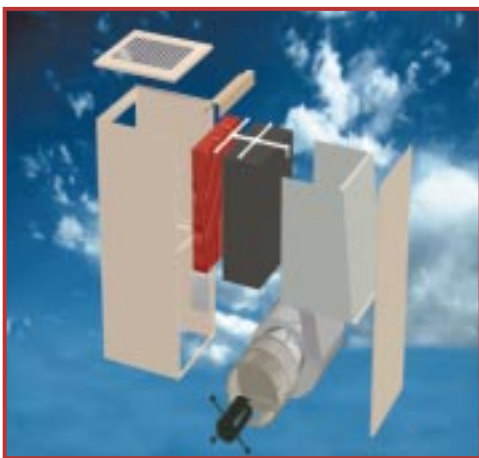
Please see the project description on Page A-5.



Project Title: High-Efficiency Lighting Torchieres

Pictured is a prototype torchiere from the Lighting Research Group at Lawrence Berkeley National Laboratory (LBNL) which uses an advanced electrodeless fluorescent source. The high-efficiency torchiere is designed for use in commercial offices where there is a demand for high color quality and low-glare portable lighting.

Please see the project description on Page A-8.



Project Title: Development of an Advanced Indirect Heat Exchange Module

Pictured is an artist's cutaway of the SmartCool™ two-stage evaporative cooler manufactured by CoolTech Industries of Fair Oaks, CA. This market-available indirect/direct advanced evaporative cooling technology was developed through the Energy Commission's Energy Technologies Advancement Program (ETAP). PIER program funding is being used to develop a new, improved heat exchanger, the indirect stage pictured in black.

Please see the project description on Page A-11.



Project Title: Design Refinement and Demonstration of a Market-Optimized Residential Heat-Pump Water Heater

Pictured is a residential heat-pump water heater being developed by Arthur D. Little, Inc. This project includes in-lab prototype durability testing followed by field testing of twenty-five prototype units in California.

Please see the project description on Page A-15.



Project Title: Removing Key Technical Barrier to Widespread Use of Advanced Absorption Cooling

Pictured is an absorption chiller manufactured by The Trane Company of La Crosse, WI. The Gas Research Institute, SRI International and The Trane Company are researching a new approach to improve the resistance of low-cost alloys by diffusion coating which changes the composition of the surface layers of the material to corrosion-resistant alloys.

Please see the project description on page A-15.

Industrial/Agricultural/Water End-Use Energy Efficiency



Project Title: Low Dross Aluminum Melter

Pictured is the furnace used by Energy Technology Solutions to test a new DC plasma arc melting technology that maintains a non-oxidizing environment, minimizing emissions volumes and the loss of aluminum as waste. This technology seeks to replace existing reverberatory furnace aluminum melters which have relatively low energy efficiency, high emissions and a large waste stream.

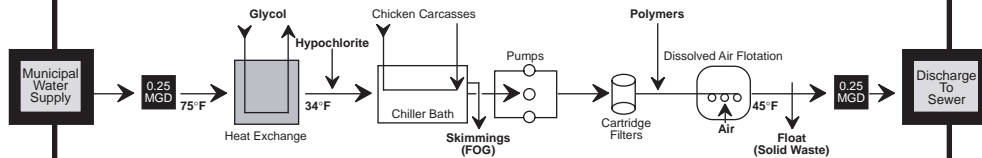
Please see the project description on page A-20.

WaterTech Partners

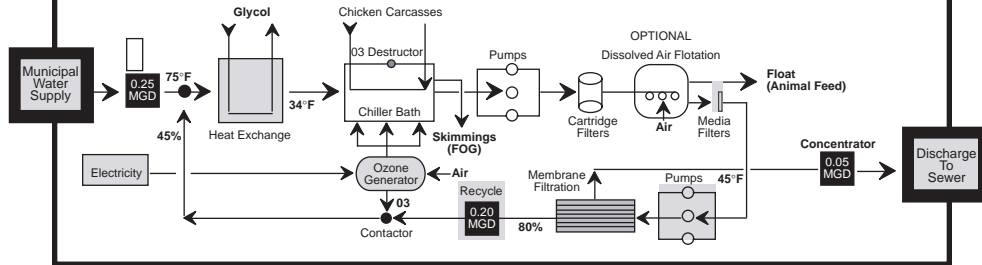
Technology to be Employed

Current Practice vs. Proposed Closed-Loop Ozone Recycle System Poultry Processing Chiller-Bath Rinse Water System Typical Plant = 250,000 birds/day @ 1.0 gallons per bird

A. Current "Once Through" System with Chlorine Disinfection



B. Proposed Recycle System with Ozone Disinfection



Project Title: Recycling Chiller-Bath Rinse Water in Poultry Processing

Pictured is a schematic comparison between the existing poultry processing chiller-bath rinse water system and WaterTech's proposed ozone recycling system. This system will be used to test the feasibility of the WaterTech Partners' Closed-Loop Ozone Recycle System at the Foster Farms Poultry Processing Plant in Livingston, CA.

Please see the project description on page A-20.

Renewable Energy Research



Project Title: Photovoltaics

Pictured is the solar-powered Ferris wheel located on the pier in Santa Monica, California. This photovoltaic array was built with PIER program funds and is part of Edison Technology Solutions' Solar Neighborhood Program effort to deploy photovoltaics into high-visibility applications to increase public awareness of the technology.

Please see the project description on Page A-23.



Pictured is the roof-mounted photovoltaic array that covers the lunch area at this elementary school in southern California. This project is part of Edison Technology Solutions' Solar Neighborhood Program effort to introduce photovoltaic technology to students as well as generate electricity for the school. This photovoltaic array was built with PIER program funds

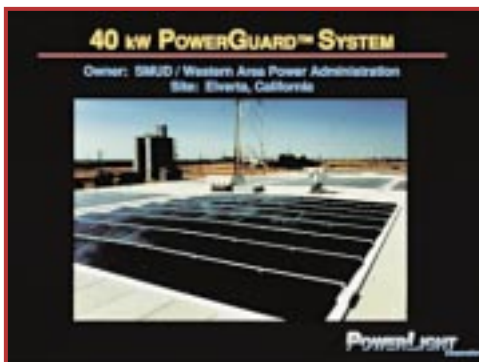
Please see the project description on Page A-23.



Project Title: Solar Two

Pictured is the Solar Two Central Receiver Project, a \$50 million proof-of-concept project co-funded by a collaborative of six electric utilities, the Electric Power Research Institute (EPRI), three industrial firms, the South Coast Air Quality Management District (SCAQMD), the US Department of Energy, and the California Energy Commission.

Please see the project description on Page A-24.



Project Title: Powertherm: A Photovoltaic/Thermal Hybrid Commercial Roofing

PowerLight Corporation will design a solar thermal component to add to their PowerGuard® photovoltaic roof-mounted electric generating system for commercial applications. The Powertherm™ addition will collect the otherwise wasted solar thermal heat for use in the building for water heating, space heating or other low-grade heat applications.

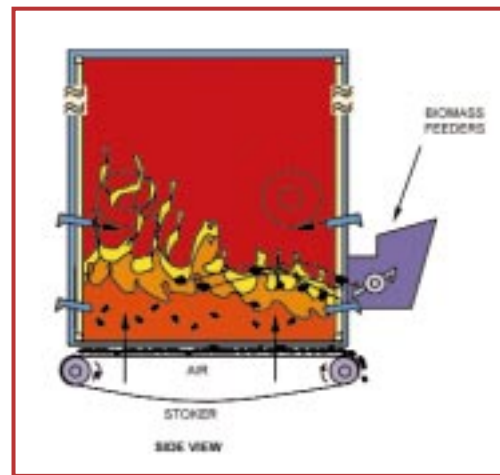
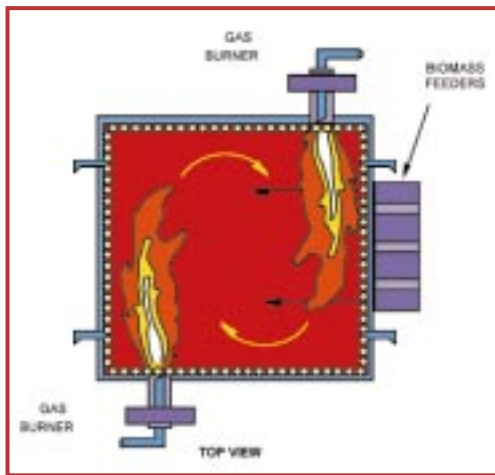
Please see the project description on Page A-25.



Project Title: Powerguard® PV System, Advanced Manufacturing Development and Scale-Up

Pictured is a schematic of PowerLight Corporation's PowerGuard® roof-mounted, electricity-producing photovoltaic system for flat to moderately sloping roofs on commercial buildings. The PowerGuard® system has been successfully fielded in dozens of applications internationally.

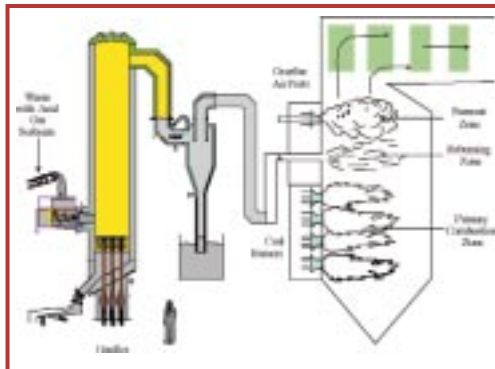
Please see the project description on Page A-28.



Project Title: Natural Gas Cofiring in Biomass Fueled Boilers

Pictured is a schematic of the Gas Research Institute's (GRI) low- NO_x , natural gas-cofire burner technology which uses dual, opposed, high-pressure drop burners which allows the gas combustion zone to strongly mix with the biomass combustion products to enhance combustion and reduce emissions.

Please see the project description on Page A-29.



Project Title: Utilization of Waste Renewable Fuels in Boilers with Minimization of Pollutant Emissions

This schematic shows a potential application of Energy and Environmental Research Corporation's Close-coupled Gasification (CCG) technology, the combination of direct combustion with reburning of waste gasification products.

Please see the project description on Page A-31.

Environmentally Preferred Advanced Generation



Project Title: Solid Oxide Fuel Cell/Micro Turbine Generation Hybrid

Pictured is a cutaway schematic of the pressurized solid oxide fuel cell/microturbine generator hybrid being developed by Edison Technology Solutions with PIER Transition Project funding. This "first of a kind" hybrid will be demonstrated at the University of California at Irvine.

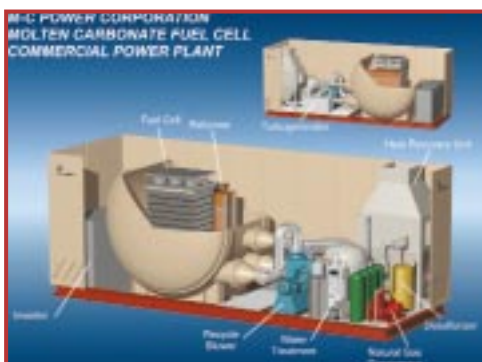
Please see the project description on page A-34.



Project Title: Micro Turbine Generator (Distributed Generation)

Pictured is the Bowman cogeneration microturbine generator being installed at the University of California at Irvine for performance testing. [the photograph] This PIER-funded project will test, for the first time, small gas turbine technology in distributed generation applications. Also pictured is an artist's cutaway schematic of the microturbine generator.

Please see the project description on Page A-35.



Project Title: 75-Kw Molten-Carbonate Fuel Cell Stack Verification Test

Pictured is an artist's schematic of the M-C Power Corporation Molten Carbonate Fuel Cell power system developed for testing at the Marine Corps Air Station Miramar located in San Diego.

Please see the project description on page A-36.

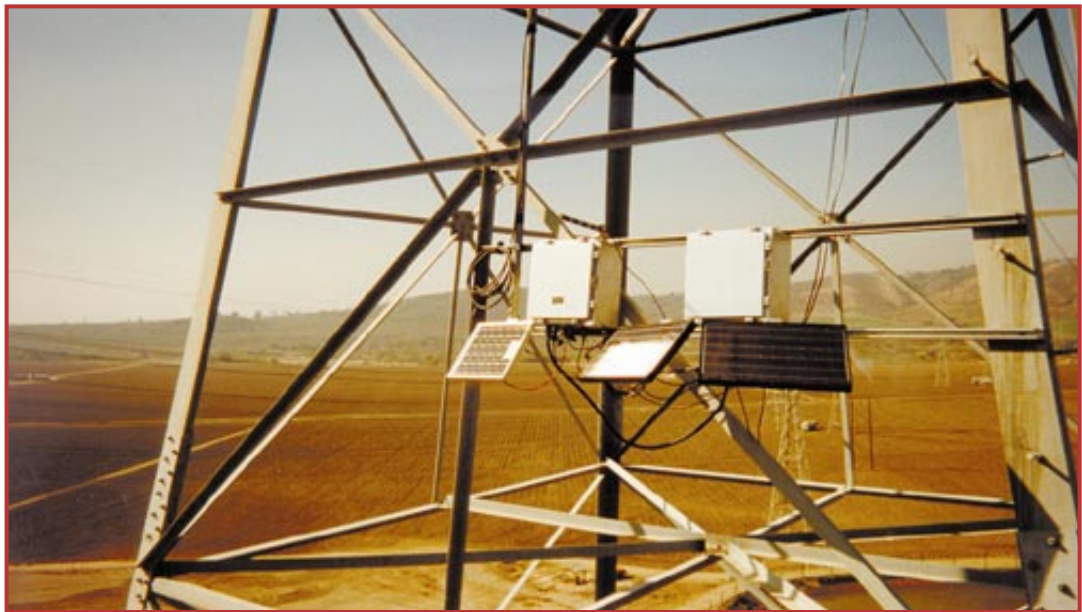
Energy-Related Environmental Research



Project Title: Wildlife Interactions with Utility Facilities

These two photos depict typical single phase transformer poles along an electric distribution circuit with new bushing covers (e.g., wildlife covers) and add-on insulation attached to jumper wires. These devices are designed to reduce the incident of wildlife-caused electrical outages and associated mortalities. In spite of the installation of many such products and other design configurations the overall incidence of wildlife-related outages is increasing in the PG&E service area.

Please see a description of the project on Page A-45.



Project Title: Dynamic Circuit Thermal Line Rating (DCTR)

Pictured are (from left to right) a cable tension monitor unit, a CatPak Transmitter and a small photovoltaic panel that runs the dynamic circuit thermal line rating system. SDG&E installed the system on a 230 kV transmission tower and uses a CatMaster receiver which collects data and sends a real-time display to system operators.

Please see the project description on Page A-52.

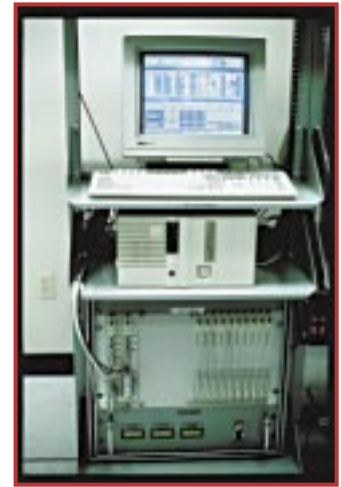
remote terminal on substation



dish - outdoor antenna



indoor part of hub terminal



Project Title: USAT MOD-2

Pictured are the components of Edison Technology Solutions' USAT MOD-2 satellite communications system. The system, also called ULTRANET™, is composed of many remote satellite earth stations connected to substation monitoring and control equipment and can be used during emergency conditions, such as an earthquake, that could cause other communications system to fail.

Please see the project description on Page A-54.



Project Title: Substation Reliability

Pictured is an electrical transmission substation. Edison Technology Solutions is researching methods to increase substation efficiency, reliability and capacity and reduce the operation and maintenance costs.

Please see the project description on Page A-55.



Project Title: 2 kWhr Flywheel Energy Storage System

Pictured is a horizontal Flywheel Motor Generator. Trinity Flywheel Power of Livermore, CA, will develop a 2 kWhr prototype Flywheel energy storage system that will be field demonstrated at a residential site in California.

Please see the project description on Page A-58.

APPENDICES

Appendix A – PIER Project Summaries

1. Building End-Use Energy Efficiency Projects	A-4
2. Industrial/Agricultural/Water End-Use Energy Efficiency Projects	A-19
3. Renewable Energy Technology Projects	A-23
4. Environmentally-Preferred Advanced Generation Projects	A-34
5. Energy-Related Environmental Research Projects	A-44
6. Strategic Energy Research Projects	A-52

Appendix B – Contributing PIER Staff Members

Appendix C – Members of the PIER Policy Advisory Council

Appendix D – Members of the Independent PIER Evaluation Panel

PIER Project Summaries

- T Transition Funding Solicitation
- 1 First General PIER Solicitation
- 2 Second General PIER Solicitation

BUILDING END-USE ENERGY EFFICIENCY PROJECTS

Photo credit: John Haigwood, Courtesy of NREL PIX



T Project Title: Residential Thermal Distribution Systems

The goal of this project is to develop information and products that will improve the energy-efficiency and performance of heating, ventilation and air conditioning (HVAC) equipment in residential buildings. This project will assess the performance of air-duct systems in California's residential buildings, develop and test duct-sealant technologies specifically designed for applications in residential buildings, and develop tools to determine the energy-performance of residential HVAC components. This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing information, tools and products to reduce HVAC energy consumption in residential buildings.

This project will develop new knowledge of residential air distribution systems and prototype technologies to assist the process of updating duct-leakage test methods. This project will also develop a test method for evaluating the longevity of duct sealants and quantifying the relationship between distribution effectiveness and HVAC equipment sizing. Currently, air leakage from the residential duct distribution systems is a major source of wasted energy. The leakage rate from existing residential units is in excess of 28 percent and a leakage rate of 22 percent or more is common in new residential units. This project will address the following likely sources of duct leakage in typical residential air distribution systems:

- leakage between the ducts and their surroundings (particularly ducts in unconditioned spaces);
- heat conduction through the duct surfaces (particularly ducts in unconditioned spaces, including transient effects and a large variability in the losses associated with different systems or different runs in the same house);
- excess infiltration and zonal temperature imbalances due to improper balancing of supply and return flows;
- heating and cooling loads while the system is off, stemming from air leakage and buoyancy-induced flows through the ducts; and

- inadequate airflow across equipment heat exchangers due to flow restrictions in the ductwork.

Successful completion of this project will result in significant energy savings in residential heating and cooling by increasing the efficiency of the distribution system.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$400,000

CIEE Project Manager: Karl Brown (510) 486-5338

CEC Project Manager: Ann Peterson (916) 654-4024

T Project Title: Evaluate Small Air Conditioning Units

The goal of this project is to evaluate the energy efficiency of small commercial air-conditioning units for use in California's hot/dry climate. This study will quantify actual energy-efficiency performance of these systems and provide this information to the HVAC market. This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing electricity customers in the commercial sector with information on energy-efficient options to cool their facilities.

This project will evaluate advanced, small commercial roof top package cooling system technologies for operation in California's hot/dry climate. Research will be conducted to determine which technologies are best suited for hot/dry climates and an evaluation plan will be developed. The current testing facility at PG&E will be enlarged or adjusted to house the equipment and additional instrumentation and testing equipment will be purchased. A quantified analysis will be performed on the selected units including a determination of energy-efficiency, demand, and cooling capacity as a function of various operating conditions. The results of this study will be incorporated into a market transformation plan and information on promising technologies will be presented to the public.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$500,000

PG&E Project Manager: Lance Elberling (925) 866-5519

CEC Project Manager: R. Michael Martin (916) 654-4039

† Project Title: Commercial Thermal Distribution Systems

The goal of this project is to develop information and products that will improve the energy-efficiency and performance of heating, ventilation and air conditioning (HVAC) equipment in commercial buildings. This project will assess the performance of air-duct systems in California's commercial buildings, develop and test duct-sealant technologies specifically designed for applications in commercial buildings, and develop tools to determine the energy-performance of commercial HVAC components. This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing information, tools and products to reduce HVAC energy consumption in commercial buildings.

This project will provide new technology and applications knowledge that will allow the construction and energy services industries to reduce energy waste in commercial thermal distribution systems. Ductwork in commercial buildings has been shown to have leakage rates of 26 percent or more. This results in unnecessary fan power requirements and/or major thermal energy losses in others. Indoor air quality can also be compromised. This project will:

- follow-through with implementation and commercialization of aerosol technology for both duct sealing and encapsulation in commercial buildings;
- implement technology transfer for improved duct design, construction and commissioning to ongoing market transformation efforts; and
- coordinate with other ongoing sub-system technology efforts (e.g. chiller systems) to create a systems optimizing approach to design.

Successful completion of this project will increase the efficiency of commercial building HVAC systems by reducing fan power caused by duct leakage and conduction losses from the thermal distribution systems, resulting in lower energy use and demand costs to the end user. It will also increase system reliability for electric utilities due to a lower thermal product loads and less peak demand. The benefits to the state include lower emissions of NO_x and CO resulting from more efficient and lower use of heating fuel resources.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$350,000

CIEE Project Manager: Karl Brown (510) 486-5338

CEC Project Manager: Mazi Shirakh (916) 654-3839

† Project Title: Diagnostics for Building Commissioning and Operations

The goal of this project is to demonstrate a system that allows building occupants to monitor the energy use within their building, so they may determine if the building is performing at its optimum energy-efficiency level. This will permit building occupants to improve the energy-efficiency of their buildings by facilitating the identification of energy performance problems. This project supports the PIER program objective of improving the energy cost/value of California's electricity by helping customers optimize their building systems to perform at their peak energy efficiency.

This project will demonstrate an advanced operator information system for whole-building commissioning and operations. The system will include high-quality sensors, a knowledge base to identify system failure, automated communications and data management and data visualization to diagnose building energy performance problems. In addition, the project will:

- develop specifications for a building monitoring, diagnostics and data-visualization system that will provide a platform for further commercial development and provide information needed to

automate the diagnosis of building energy performance problems;

- develop, install, test and demonstrate a building performance measurement and diagnostic solution; and
- improve energy efficiency and decrease peak demand by providing technical leadership and support in transforming the market for building energy performance monitoring and diagnostics systems.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$350,000

CIEE Project Manager: Carl Blumstein (510) 642-9590 ext.202

CEC Contract Manager: Joseph Wang (916) 654-4026

^TProject Title: Building Design Advisor

The goal of this project is to test a software package that allows designers to include energy-efficient options in the earliest stages of building design. After the initial testing is complete, a final product will be developed and made available to the public, possibly as a web-based application. This project supports the PIER program objective of improving the energy cost/value of California's electricity by allowing energy-saving measures to be integrated into the early design of a building, thereby making energy-efficient measures more cost effective.

This project will improve the use of sophisticated energy analysis tools for use in the schematic phase of building design. These analyses will make it easier for decision-makers to quantitatively assess the energy and non-energy implications of energy-efficient building strategies and technologies. These tools help reduce the risk of considering efficient options in the design of new buildings or the retrofiting of existing buildings.

This project will develop the Building Design Advisor, a Windows-based computer program that facilitates decision making through integrated use of multiple analysis tools and databases. This tool enables building designers to consider various energy efficiency options

during the design stage of new buildings, when energy efficiency measures are typically more cost effective. A link will be developed to the DOE-2 building energy simulation program, an industry standard for detailed, accurate energy performance simulations.

Successful completion and widespread use of the technology developed through this project will promote the use of advanced energy efficiency options during the design stages of new and retrofit building construction by instilling more confidence in building construction designers/decision makers for new energy-efficient building strategies and technologies.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$350,000

CIEE Project Manager: Carl Blumstein (510) 642-9590 ext.202

CEC Project Manager: Tav Commins (916) 653-1598

^TProject Title: Improve the Cost Effectiveness of Building Commissioning Using New Technologies for Measurement, Verification and Analysis

The goal of this project is to investigate and demonstrate cost-effective and energy-efficient methods for the commissioning of medium to large buildings that have complex mechanical, lighting, and energy management control systems. Commissioning ensures that buildings designed for maximum energy-efficiency perform as intended, thereby reducing energy costs associated with building operations. This project supports the PIER program objective of improving the energy cost/value of California's electricity by developing tools to analyze, and guarantee, the performance of energy-efficiency measures.

A major obstacle to widespread adoption of building commissioning is cost. This project will create commissioning techniques more effective and less costly to implement. These techniques will be tested in a laboratory and a demonstration site to evaluate their performance. The system will include high-quality sensors, a knowledge

base to identify system failure, automated communications and data management and data visualization to diagnose building energy performance problems. In addition, the project will:

- develop specifications for a building monitoring, diagnostics and data-visualization system that will provide a platform for further commercial development and provide information needed to automate the diagnosis of building energy performance problems;
- develop, install, test and demonstrate a building performance measurement and diagnostic solution; and
- improve energy efficiency and decrease peak demand by providing technical leadership and support in transforming the market for building energy performance monitoring and diagnostics systems.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$300,000

PG&E Project Manager: Steve Blanc (925) 866-5570

CEC Contract Manager: Joseph Wang (916) 654-4026

† Project Title: Improve the Cost Effectiveness of Building Control Systems Sensing and Data Collection

The goal of this project is to investigate methods to reduce the costs of current energy-management systems, such as low-cost building control systems and sensors. Energy management systems allow utility customers to monitor and control their energy consumption and improve the energy-efficiency of the whole building. This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing utility customers with tools to reduce their energy consumption.

This project will investigate solutions to the data acquisition and monitoring challenges faced when using energy management systems for advanced control, performance monitoring, diagnostics and commissioning.

In addition, this project will develop a methodology to 1) choose the measurement and monitoring points needed to accomplish building commissioning goals; and 2) determine the required accuracy and collection frequency and calibration intervals of those measurements. This methodology will be used as a guideline for the purpose of improved building performance monitoring, diagnostics, operation and significant energy savings.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$250,000

PG&E Project Manager: Steve Blanc (925) 866-5570

CEC Contract Manager: Joseph Wang (916) 654-4026

† Project Title: Alternatives to Compressor Cooling

The goal of this project is to help residents living in California's inland, transition climate zone save energy and reduce their home cooling bills by developing and testing user-friendly controls for energy-efficient cooling technologies. These new user controls will allow consumers to use various energy-efficient cooling systems as alternatives to conventional compressor-based cooling that is usually unnecessary in the transition climate zone. This project addresses the PIER program objective of improving the energy cost/value of California's electricity by offering consumers in the transitional climate zone an energy-efficient and money-saving alternative to cool their homes.

This project will develop and evaluate a prototype low-energy cooling control system for use with a variety of low-energy cooling systems. Specific attention will be given to the issues of system-supplied user information, degree of control and interface intelligibility.

Compressor-based cooling is growing rapidly in transition climate zones inland from major California coastal urban centers. However, the low hours of air conditioning used in these areas create an extremely poor load factor with a substantial adverse effect on costs of service and electric system operations. This project will:

- evaluate pilot houses and /or subdivisions using project-developed house designs;
- develop a prototype cost/capability-optimized alternative cooling system controller;
- provide technology transfer through design information dissemination/assistance/evaluation;
- promote the project with design competitions; and
- develop applications information to assist market transformation programs.

Successful completion and integration of the results of this project into the residential building sector will result in lower-cost cooling systems in new homes located within the transition climates of California.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$350,000

CIEE Project Manager: Karl Brown (510) 486-5338

CEC Project Manager: Randel Riedel (916) 654-4109

Project Title: High-Efficiency Lighting Torchieres

The goal of this project is to develop and test the next generation of advanced, energy-efficient, electrodeless high-lumen output fluorescent lamps. These lamps represent the next generation in terms of efficacy, or effectiveness, advantages. This project will focus on applications in commercial office buildings that have high lighting demands. This project supports the PIER program objective of improving the energy cost/value of California's electricity by developing and demonstrating new energy-efficient and high-quality lighting torchieres for site-specific office lighting.

These advanced torchieres utilize a high-efficiency, tri-component phosphors (synthetic fluorescent or phosphorescent substances) with very high color quality. Removing the electrodes and using inductive coupling results in significant increases in the efficacy and life characteristics of these lamps. In addition, these lamps have very high lumen output, in the 10,000-lumen range at

approximately 100 – 120 watts. The high lumen output presents some very significant challenges in terms of effectively distributing the light within typical office spaces, particularly with indirect lighting.

This project will also develop a portable, high-efficiency, indirect torchiere fixture that will use one of the next generation high-efficacy electrodeless fluorescent lamps. These fixtures are targeted at the commercial office interiors where there is a demand for high color quality and low-glare portable lighting. This proposed effort is a first step in the development and demonstration of new office torchiere lighting systems.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$90,000

CIEE Project Manager: Carl Blumstein (510) 642-9590 ext.202

CEC Project Manager: Mazi Shirakh (916) 654-3839

Project Title: CIEE Collaborative Program Planning and Management

This project coordinates the efforts undertaken in the eight University of California-California Institute for Energy Efficiency (CIEE) Transition Program contracts. These CIEE transition-solicitation funded projects support the PIER program objective of improving the energy cost/value of California's electricity by increasing the energy efficiency of residential and commercial buildings.

This project will provide planning, funding, management and technology transfer activities for the CIEE Transition Program projects. Under this agreement CIEE is the primary link between the Commission's project managers and the principal investigators. The CIEE will also ensure that the administrative and reporting requirements of each project are being met.

CIEE also organizes regular meetings of its Research Board and its Planning Committee so that the progress on these multi-year projects can be assessed and mid-course corrections made if necessary. A Triennial Review of CIEE's program will be undertaken as part of this project.

As part of its activities, the CIEE will finalize and issue an RFP for the first phase of a new multi-year project: Market Transformation Research: New Commercial Buildings. Once in place, CIEE will manage this project in a similar fashion to the other projects covered in this agreement.

The CIEE will update and maintain an Internet website that contains pertinent information about its program and each of the eight Transition Program projects. They will also integrate information and technology transfer activities into each of these projects, helping to ensure that the results reach the right audiences.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$600,000

CIEE Project Manager: Jim Cole (510) 486-4123

CEC Project Manager: Gary Klein (916) 653-8555

¹Project Title: Food Service Technology Center

The goal of this project is to integrate a two-part effort to investigate ways to reduce the release of cooking-related emissions from the exhaust systems of commercial kitchens and minimize the amount of building energy associated with the operation of such systems. Because of the large number of commercial kitchens in California, researching this sector's emission characteristics is a significant step toward mitigating the release of particulate matter (PM) from charbroiling and volatile organic compounds (VOCs) from other cooking processes. This project supports the PIER program objective of improving the energy cost/value and environmental and public health costs/risk of California's electricity by investigating energy-efficient ventilation technologies for commercial kitchens that will also help improve air quality by reducing PM and VOCs from commercial kitchens.

This project will focus on developing industry-wide guidelines for designing, installing and operating ventilation systems in terms of effectiveness and energy efficiency. This research is being conducted at PG&E's

Food Service Technology Center in San Ramon, California and will involve the following tasks:

- Development of uniform test methods for characterizing emissions from commercial kitchens;
- Characterization of emissions with regard to composition and major sources; and
- Development of effective control approaches.

Results from this research will be disseminated through workshops and publications for the benefit of the industry and regulatory agencies concerned about these emissions. For example, the South Coast Air Quality Management District (SCAQMD) is trying to specify limits on the emission of particulates from commercial charbroiling operations in its air basin.

The state will benefit from this research by obtaining information necessary to reduce emissions from commercial kitchens. Further benefits will result from the use of more energy-efficient exhaust ventilation systems. Improved ventilation efficiency will also help reduce the amount of indoor pollution in commercial kitchens and their immediate vicinities.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$350,000

PG&E Project Manager: Grant Brohard (925) 866-5713

CEC Contract Manager: Obed Odoemelam (916) 654-4171

²Project Title: Energy Efficient Downlights for California Kitchens

The goal of this project is to research, develop and demonstrate low-cost, energy-efficient compact fluorescent (CFL) downlights designed specifically for residential kitchen applications. Kitchen lighting is the largest lighting energy user in Californian homes, accounting for one-quarter of residential lighting operating costs. These kitchen environments have a large energy savings potential, particularly in new construction. This project supports the PIER program objective of improving the energy cost/value of California's electricity by overcoming technical and market issues such as lighting quality, the inability to

dim and the high initial costs for CFLs which have provided barriers to the widespread use of CFLs in the residential sector.

The first objective in addressing these barriers involves the development of single, dimming, electronic ballasts that control multiple CFL downlights. This technical development will reduce the number of ballasts required for a typical kitchen layout of 4-6 fixtures by 75 to 80 percent. This reduction represents an important technical achievement since the highest contributing cost of a CFL downlight system is the ballasts. In CFL downlights with dimming capability, the cost of the ballast can approach 75 percent of the total luminaire cost. This new system will provide high-quality, high-performance, energy-efficient lighting with a significant decrease in initial costs over current CFL downlights.

Another major objective involves the development of thermoplastic fixtures with high efficiency coatings. Current downlight reflector efficiencies range between 50-70 percent with the industry standard at approximately 65 percent. The relatively low efficiency of these fixtures is a function of their manufacturing process, which leads to a predominance of rotationally symmetrical reflectors. While these symmetric reflectors are fairly efficient in optically managing small incandescent sources, they do poorly at handling complex CFL lamps. In contrast, injection molding and other plastic molding processes can generate the complicated, optically efficient geometries that will result in output efficiency increases of 15-25 percent over existing CFL reflectors.

Successful completion of this project, concluding with a decrease in the price of CFL dimming ballasts that control multiple CFL downlights, will result in overall lower initial costs for CFLs for kitchen lighting making them more attractive to homeowners. In addition, a 15-25 percent increase in output efficiency will further increase the attractiveness of CFL downlights used to illuminate kitchens, where typically, brighter-than-average light is required for food preparation.

Contract Number: 500-98-020

Contractor: Lawrence Berkeley National Laboratory (LBNL)

Contract amount: \$648,603 Match funding: \$320,028

LBNL Project Manager: Stephen Johnson (510) 486-4274

CEC Contract Manager: Elaine Hussey (916) 654-5006

²Project Title: Increased Energy Efficiency of Refrigerators and Air Conditioners Through Use of Advanced Power Electronics

The goal of this project is to develop an energy-efficient electronic control system by which refrigerators and heat pumps with single-phase compressor motors can be operated more energy efficiently using three-phase motors. Because three-phase motors are more efficient and less costly to manufacture, there is a significant potential for reducing the electrical consumption of refrigerators and other residential appliances. In addition, this project will help decrease the load energy consumption of air conditioners that have a significant effect on peak loads. This project supports the PIER program objective of improving the energy cost/value of California's electricity by making an existing energy technology more efficient, thereby lowering the cost of electricity for refrigeration and cooling to residential customers. The project also supports the PIER program objective of improving the reliability/quality of California's electricity by helping to reduce peak electrical demand from residential cooling.

In this project, Windlite Corporation will develop and demonstrate innovative proprietary power electronics to convert single-phase power to three-phase power. This significantly reduces conversion losses, making the use of three-phase motors economically feasible for residential applications. WindLite will purchase and modify two compressors and install one in a conventional design high-efficiency refrigerator and the other in a conventional design heat pump. The modified refrigerator and modified heat pump will be tested and their energy efficiency compared against an unmodified refrigerator and an unmodified heat pump.

Successful completion of this project will increase the efficiency of residential refrigerators by approximately 19 percent with no increase in cost to consumers. The technology is applicable to other residential appliances that use single-phase motors such as air conditioners, heat pumps, washing machines and clothes dryers, which promises huge energy savings potential for residential appliances.

Contract Number: 500-98-021

Contractor: Windlite Corporation

Contract amount: \$411,614 Match funding: \$114,714

Windlite Corporation Project Manager: Dr. T.S. (Jay) Jayadev (650) 964-1596

CEC Contract Manager: R. Michael Martin (916) 654-4039

²Project Title: Development of an Advanced Indirect Heat Exchange Module

The goal of this project is to improve the energy-related performance and reduce the cost of SmartCool™, a low-cost, energy-efficient cooling technology for residential and small commercial buildings. This project will develop an indirect heat exchanger for the advanced two-stage evaporative cooler. This new indirect stage module will lower the cost as well as increase the reliability and energy efficiency of the SmartCool™. This project supports the PIER program objective of improving the energy cost/value of California's electricity by refining a new energy efficiency technology to make it more market ready. It also supports the PIER program objective of improving the reliability/quality of California's electricity by developing an air conditioning technology that contributes considerably less to peak electrical demand than conventional air conditioning units.

The Davis Energy Group will develop and test an advanced indirect evaporative cooling stage (heat exchanger) for the SmartCool™ two-stage evaporative cooler produced by CoolTech Industries of Fair Oaks, CA. This unit is the "next-generation" of evaporative coolers, providing low-humidity comfort comparable to typical air

conditioning but with approximately 30 percent lower installation costs and 60-80 percent less operating costs. The original SmartCool™ was designed to use an indirect stage manufactured by an out-of-state company. CoolTech Industries continues to use this indirect stage out of necessity. It is anticipated that the improved indirect heat exchanger will cost under \$70, substantially less than the \$220 now paid for each unit. This will help reduce the SmartCool™ cost by over \$300, as there are two units for each module. This project will help reduce the wholesale and retail cost of the unit and improve the effectiveness of the SmartCool™ by 5 percent.

This advanced indirect/direct evaporative cooler technology development was previously funded through the Commission's Energy Technologies Advancement Program (ETAP). The SmartCool™ has been commercialized and can compete directly with compressor-based cooling in most of California and the southwestern United States. In addition, the new, improved indirect evaporative heat exchanger can be assembled with varying numbers of parallel plates to provide a range of SmartCool™ sizes. The product has been featured in *Popular Science* and has had feature articles published in *Energy Design Update* and *The Sacramento Bee*. CoolTech Industries hopes to be producing 2000 of the improved units per year by the year 2000.

Contract Number: 500-98-022

Contractor: Davis Energy Group, Inc. (DEG)

Contract amount: \$248,719 Match funding: \$84,618

Davis Energy Group Project Manager: Richard Bourne, P.E. (916) 753-1100

CEC Contract Manager: Ray Darby, P.E. (916) 654-5074

²Project Title: Conceptual Design Energy Analysis Tool (CDEAT)

The goal of the Conceptual Design Energy Analysis Tool (CDEAT) project is to develop a commercially viable, self-supporting software product that will facilitate the estimation of building energy consumption during the

early stages of architectural design. The work is intended to produce an affordable, user-friendly software tool having superior performance over any other commercially available product. This project supports the PIER program objective of improving the energy cost/value of California's electricity by helping architects, design/build contractors and developers generate reliable estimates of the energy performance of a building while it is still in its earliest stage of design.

RLW Analytics, Inc./Geopraxis, Inc. will design and develop an easy-to-use, market transforming energy analysis software module (based on simulation technology) that will be seamlessly integrated with an existing 3-D conceptual building design software tool. Target users will be energy non-experts, (primarily architects, design/build contractors, developers) who will be able to generate reliable estimates of the relative energy performance of a new building in its earliest stage of design. The tool's parametric capabilities will allow users to understand and test the energy-related impacts of their designs, including fuel and materials choices, system types, orientation, fenestration layout and other key decisions which often become fixed at this early stage of the construction process.

The Energy Analysis Module (EAM), the center of the conceptual design tool, will be designed with an open and public interface specification, allowing it to be integrated with other 3-D tools and future energy simulation engines offered by competing vendors. This provision will ensure that CEC funding does not produce a tool that is bound to a single proprietary 3-D program. This project promises to help transform the process of conceptual design, and offers the potential to readily integrate future energy-related advances in building materials or end use technologies, and help speed their market penetration.

Contract Number: 500-98-023

Contractor: RLW Analytics, Inc./GeoPraxis, Inc.

Contract amount: \$452,655 Match funding: \$194,900

GeoPraxis Project Manager: Tom Conlon (707) 996-9408

CEC Contract Manager: Tav Commings (916) 653-1598

²Project Title: Alternative to Compressor Cooling: Phase V Integrated Ventilation Cooling

The goal of this project is to prepare ventilation-cooled, integrated residential building design packages to raise comfort standards and reduce energy use in California's inland transition climate zone. This project supports the PIER program objective of improving the energy cost/ value of California's electricity to end users by improving comfort, affordability, reliability, environment/safety, and economic productivity as well as lowering transition climate cooling costs and capacity load factors.

This project will continue developing and evaluating alternatives to compressor cooling for residential buildings in California's transition climates that are being increasingly populated as suburban sprawl expands inland from California's coastal urban areas. The climate is substantially cooler than the central valleys, but current construction practice is to install central air conditioning uniformly in virtually all locations. The very low number of hours of use in the transition areas creates extremely poor load factors of 5 percent or less, making residential air conditioning one of the least cost-effective loads to serve. The relatively high distribution and transmission capacity development costs to serve these peak loads increases residential rates. This project will address building design equipment and installation improvements identified in Phase III and implement new features to develop an integrated heating, ventilation and cooling package (HVC) ready for market introduction.

House designs have been developed in previous project phases for coastal "transition" climates that, with the use of night ventilation cooling, require little or no air conditioning. A house design will be developed in this phase specifically for inland valley climates. With ventilation cooling provided by the HVC unit to be developed by this project, the inland design is projected to require no larger than a 1.5 ton air conditioner. The night vent cooling mechanical system and controls will be tested in at least two homes built to Alternatives to Compressor

Cooling (ACC) project specifications. Performance and owner response will be evaluated.

In addition to integrating dampers for night ventilation cooling, the HVC unit will include a fan coil which will heat the house using the domestic hot water, a variable speed blower motor for quiet, efficient heating and ventilation, and an optional refrigerant coil for compressor-based cooling. Advanced controls, which convey the concept of ventilation cooling to the user, will be improved in this project phase.

Contract Number: 500-98-024

Contractor: Davis Energy Group (DEG)

Contract amount: \$713,246 Match funding: \$150,437

DEG Project Manager: David Springer (916) 753-1100

CEC Contract Manager: Randel Riedel (916) 654-4109

²**Project Title: A Tool for the Comprehensive Analysis of Low-Rise Residential Buildings**

The goal of this project is to develop an energy design and analysis software program which enables homeowners and members of the low-rise (less than three stories) residential building sector to perform a variety of energy efficiency analyses. The project will enable the residential building sector to design more energy-efficient homes by using a whole house design methodology which integrates the building envelope, HVAC, lighting and water heating systems. This project supports the PIER program objective of improving the energy cost/value of electricity in California by enabling residential customers to choose energy service providers offering them the best combination of electric rates and energy conservation services by giving them a better understanding of energy usage patterns and load profiles.

This contract will develop a Windows-based design and analysis tool that will assist homeowners and design professionals in evaluating the energy use of residential buildings, taking into account the new complexities of the restructured electricity market. The project will build on two significant existing technologies, the DOE-2.2

calculation engine and a set of foundation classes developed by Eley Associates. The foundation classes exist as a separate software component and provide functionality to the interface including file input/output, graphic services, model construction and component editing capabilities. The technical objective of this project is to leverage these existing software technologies to produce a tool that will be useful to a wide sector of the residential building community.

With a deregulated electricity market, proposals from energy service providers will likely become more complex with time-of-use charges, demand charges, ratchets and perhaps real-time pricing. This tool will enable the unregulated market for electricity to function at a more optimum level because it will enable homeowners to understand their energy use patterns and be better informed in choosing an energy service provider in the unregulated marketplace. In addition, it will enable architects, building designers, contractors and homeowners to evaluate design and/or equipment alternatives and make better decisions about which design strategies to employ or which equipment to specify.

Contract Number: 500-98-025

Contractor: ELEY Associates

Contract amount: \$216,190 Match funding: \$200,000

ELEY Associates Project Manager: Charles Eley (415) 957-1977

CEC Contract Manager: John Eash (916) 653-7181

²**Project Title: HVAC Distribution Systems in Commercial Buildings**

The goal of this project is to provide the scientific knowledge needed to improve the energy efficiency of the heating, ventilation and air conditioning (HVAC) distribution systems of California commercial buildings. Approximately one third of the electricity used in California commercial buildings is consumed by HVAC equipment. This project supports the PIER program objective of improving the energy cost/value of California's electricity by determining how leaky or inadequately designed air distribution (duct) systems in commercial buildings waste

energy used to condition (cool, heat, dehumidify) air and by developing methods to correct these problem systems.

Lawrence Berkeley National Laboratory (LBNL) will refine or develop diagnostic tools to measure the performance of commercial thermal distribution systems and develop and evaluate duct improvement technologies for these systems. The project will provide the scientific knowledge needed to get improved air distribution systems into California commercial buildings. It includes field measurement before and after retrofits, development of diagnostic protocols, and development and evaluation of advanced sealing and coating retrofit technologies. Some of major problems identified in commercial thermal distribution systems include: 1) duct leakage levels of approximately 25% of fan flow, 2) 50% of light commercial ductwork located in unconditioned spaces, and 3) fan power increases of more than 100% due to leakage and conduction losses from conditioned-space ductwork.

Successful completion of this project will provide a more efficient use of electricity in HVAC systems by reducing air leakage from the thermal distribution systems, resulting in a reduction fan power and thermal product loads. The benefits include lower energy and demand costs for the end users and increased system reliability for the electric utilities due to a lower HVAC peak demand.

Contract Number: 500-98-026

Contractor: Lawrence Berkeley National Laboratory (LBNL)

Contract amount: \$537,000 Match funding: \$413,000

LBNL Project Manager: Mark P. Modera (510) 486-4678

CEC Contract Manager: Mazi Shirakb (916) 654-3839

²Project Title: Building Specification Guidelines for Energy Efficiency

The goal of this project is to develop a set of reference specifications for specific energy-efficiency equipment or technologies for commercial buildings that are cost effective to install but for which information is currently inadequate. These specifications will help eliminate a barrier to energy efficient design. This project supports the PIER program objective of improving the energy cost/value

of California's electricity by influencing standard construction practices and future building and system energy use in the commercial sector. It also supports the PIER program objective of maximizing market connection by making these specifications available to the public in a format that can be incorporated into construction documents.

Engineers, building designers, architects and other design professionals have found that energy efficient equipment specifications are often difficult to find and time consuming to research. This project is envisioned to remove the barriers toward specifying energy efficient equipment and technologies for commercial buildings by:

- simplifying the specifications of some technologies;
- addressing project commissioning and monitoring within each of the technologies;
- providing specifications for advanced cost-effective technologies;
- addressing integrated controls and open protocols for commercial lighting and heating, ventilating and air conditioning (HVAC) systems; and
- disseminating the new specifications to the industry through the Internet

Once the specifications have been tested by the Contractor's team and reviewed by building design professionals (such as engineers, building designers, architects, and lighting designers), they will be made available through the Internet. This format will facilitate the use and incorporation of these specifications in construction documents by design professionals. In addition, equipment manufacturers will also understand what they need to build to satisfy the efficiency market.

Contract Number: 500-98-027

Contractor: ELEY Associates

Contract amount: \$233,280

ELEY Associates Project Manager: Charles Eley (415) 957-1977

CEC Contract Manager: Virginia Lew (916) 654-3838

²**Project Title: Design Refinement and Demonstration of a Market-Optimized Residential Heat-Pump Water Heater**

The goal of this project is to design, test and demonstrate a market-optimized residential heat-pump water heater. The primary goals of this project are to: 1) identify and implement design refinements to lower initial and operation costs and increase performance; 2) perform laboratory tests to demonstrate the durability/reliability of the design; and 3) demonstrate the performance, reliability and ease of installation through a California-based field test. This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing a low-cost, highly reliable and durable residential heat-pump water heater (HPWH).

The economic performance objective for the fabrication and installation of the HPWH is to reduce its total installed cost from \$1,200 to \$875. The technical performance objective for the project is to make the water heater capable of achieving at least a 2.0 energy factor, the standard performance measure for water heaters using a test procedure prescribed by the U.S. Department of Energy.

The project will include the following stages:

- Cost reduction in component design and selection – A.D. Little, Inc. will design for the following items:
 - Compressor selection;
 - Condenser thermal bond to tank wall;
 - Expansion device selection;
 - Refinement and cost/performance optimization of control system; and
 - Evaluation of fan noise and power draw trade-offs associated with maximizing evaporator capacity.
- Fabrication and laboratory testing of third-generation prototype to verify performance.
- Durability testing on three prototypes for one year under laboratory conditions.

- Field testing of twenty-five prototype units in California residences.

Contract Number: 500-98-028

Contractor: Arthur D. Little, Inc. (ADL)

Contract amount: \$756,095 Match funding: \$109,235

ADL Project Manager: Robert A. Zogg (617) 498-6081

CEC Contract Manager: Tony Wong (916) 654-4015

²**Project Title: Removing Key Technical Barrier to Widespread Use of Advanced Absorption Cooling**

The goal of this project is to improve the energy efficiency and lower the cost of natural gas-fired absorption chillers. This project will study and support continued development of new corrosion resistant materials, applied as a thin diffusion coating on low-cost materials of a commercial air conditioning system that uses an advanced absorption chiller. The project supports the PIER program objective of improving the reliability/quality of California's electricity by working towards the development of a low-cost absorption chiller that uses natural gas. By using natural gas, the consumption of electricity within the State will decrease. It also supports the PIER program objective of impacting California's state and local economies by potentially increasing California's production of absorption chillers and installation capacity.

Gas-fired advanced absorption cycles offer an attractive alternative to electrical heating, cooling and refrigeration by providing energy directly from natural gas, lowering electricity demand. These advanced absorption cycles convert fuel energy to heating or cooling with very high efficiencies. However, absorption chillers are more expensive than electric chillers, limiting their industrial acceptance. One major factor for the higher capital cost of absorption chillers is the high cost of corrosion-resistant alloys, demanded by high operating temperatures and corrosive chemicals used in advanced absorption cycles. The project goals include reducing the capital and maintenance costs and extending the service life of the equipment by use of the diffusion-coated products

developed by this contract. The ultimate objective of this project is to increase the widespread use of economical, energy-efficient advanced absorption cycles in California to reduce peak electricity demand, cost of electricity and pollution resulting from electricity generation.

The Gas Research Institute (GRI), in association with SRI International and the Trane Company, is working on a revolutionary new approach to improve the corrosion resistance of low-cost alloys. This approach takes a low-cost copper or mild steel base material and applies a diffusion coating which changes the composition of the surface layers of the material to corrosion-resistant alloys. Unlike plating processes, diffusion coatings penetrate into the base material with a smooth gradual transition between the base material and the surface material. The difference in cost between the high quality corrosion-resistant alloys used in absorption chillers and current estimates on the diffusion-coated materials is quite dramatic, dropping from 600-700 percent above of the cost of mild steel to 20-30 percent more expensive than mild steel.

Contract Number: 500-98-029

Contractor: Gas Research Institute (GRI)

Contract amount: \$690,178 Match funding: \$235,000

GRI Project Manager: Kevin Krist (773) 399-8211

CEC Contract Manager: Brad Meister (916) 653-1594

²Project Title: Improving Energy Efficiency of Commercial Kitchen Exhaust Systems

The goal of this project is to improve the energy efficiency of commercial kitchen ventilation systems by performing flow-visualization research of a variety of ventilation systems and publishing design guidelines for the food service industry. This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing more energy efficient methods for ventilating commercial kitchens.

The project will test wall-mounted, canopy-style hoods with parametric (fixed limit or boundary) makeup air configurations, island-mounted, canopy-style hoods with

parametric makeup air configurations and backshelf-style hoods with parametric makeup air configurations. The project will create methods, standards and tools available for use by all manufacturers and ratepayers. The project will also expand the data base on kitchen ventilation system efficiency, providing purchasers with energy efficient options while encouraging manufacturers to raise the base efficiency of a given hood style. The results of this project will equally benefit all commercial food service ventilation equipment manufacturers and commercial food service owners and operators.

Contract Number: 500-98-031

Contractor: Pacific Gas and Electric Company (PG&E)

Contract amount: \$276,165 Match funding: \$225,000

PG&E Project Manager: Grant Brohard (925) 866-5713

CEC Contract Manager: Tony Wong (916) 654-4015

²Project Title: Instrumented Home Energy Rating and Commissioning

The goal of this project is to demonstrate the energy saving value that performing building commissioning services would have in both new and existing residences and to develop and document residential building commissioning procedures. This project supports the PIER program objective of improving the energy cost/value of California's electricity by helping customers optimize their building systems to perform at their peak energy efficiency. In addition, this project supports the PIER program objective of maximizing market connection by forming a project advisory committee with participants representing the building industry (builders and HVAC contractors) and home energy rating professionals, as well as utility and government organizations. The advisory committee's participation will ensure that the research and products of this project are relevant and connected to the market.

This project will develop diagnostic and audit tools, metrics for evaluating energy-related performance, and commissioning guidelines for new and existing houses. The goal of the project is to lay the groundwork for a residential commissioning industry.

The technical objectives will:

- advance our understanding of how the commissioning of new and existing houses would be of benefit to the consumer, utilities, the building industry and the State of California;
- develop norms and metrics for evaluating the performance of the components of a building with respect to energy and commissioning in California;
- adapt and develop diagnostics and audit tools for use in residential commissioning;
- develop commissioning guidelines for new and existing houses; and
- undertake outreach efforts to the building, services, regulatory and professional communities, to ensure that the guidelines are appropriately utilized.

Contract Number: 500-98-033

Contractor: Lawrence Berkeley National Laboratory (LBNL)

Contract amount: \$710,000 Match funding: \$137,000

LBNL Project Manager: Max H. Sherman (510) 486-4022

CEC Contract Manager: Ann Peterson (916) 654-4024

²Project Title: Investigation of Secondary Loop Supermarket Refrigeration Systems

The goal of this project is to design and test an energy efficient secondary loop refrigeration system for supermarkets. Supermarkets are one of the largest consumers of electric energy in the commercial sector, with a typical supermarket consuming two to three million kWh annually. The largest single use of energy in a supermarket is for the refrigeration or freezing of perishable food stocks. Operating cost is of great significance to supermarkets because of the small profit margins involved in food retailing. Therefore, technologies that offer better performance and the potential for lowering operating cost are of interest to supermarket operators even if a first cost premium exists.

This project supports the PIER program objective of improving the energy cost/value of California's electricity by helping lower the operating costs of supermarkets by

providing refrigeration more efficiently and cost effectively. In addition, this project supports the PIER program objective of improving environmental and public health costs/risks of California's electricity by enabling supermarkets to use less refrigerant that depletes global ozone and contributes to global warming.

The proposed project will identify possible system improvements, such as 1) variable-speed pumping, 2) evaporative condensing, 3) subcooling, and 4) low head operations. For the proposed project, an advanced secondary loop system will be analyzed and designed to achieve maximum energy efficiency. The advanced system will be fabricated and installed in an operating supermarket and be instrumented to measure its performance. A second baseline store using a state-of-the-art multiplex system will also be instrumented. A field test of both systems shall be conducted where performance and energy consumption of each system are compared. The expected goal reduction of energy consumption will be approximately 13.9%.

Historically, the number of supermarkets has increased only slightly since the construction of a new supermarket is often accompanied by the closing of an older store. The rate of replacement of stores through new construction or major remodel from old to new is approximately 10 percent annually. At this rate, all of the 3,025 California stores will be replaced or remodeled to a newer store in approximately 10 years.

Contract Number: 500-98-039

Contractor: Southern California Edison (SCE)

Contract amount: \$300,000 Match funding: \$150,000 (Safeway Stores, Inc.)

SCE Project Manager: Ramin Faramarzi (909) 394-8683

CEC Contract Manager: Nelson Pena (916) 654-4217

²Project Title: Next-Generation Power Management User Interface for Office Equipment

The goal of this contract is to assess and develop energy-efficient power management interface standards

adaptable to a variety of office equipment and appliances used in commercial buildings. Electricity savings from power management of office equipment has been one of energy efficiency's premier success stories. Despite this success, many devices that are capable of power management are not saving energy because the power management features are disabled, incorrectly configured, or thwarted by a hardware or software conflict. The purpose of this project is to capture energy savings by increasing the rate at which power management is enabled and operates successfully. This project supports the PIER program objective of improving the energy cost/value of California's electricity by improving the energy efficiency of commercial-sector office equipment and appliances.

The research aspect of this project is to discover the characteristics and elements of an optimal standard user interface and then develop more effective and standardized user interfaces. The proposed standard interface will then be subjected to critical review from the broad community of interface designers and users to identify any shortcomings and modify the standard as needed.

Technical challenges include identifying interface elements that people find the clearest and simplest, and a system which meets the needs of all manufacturers. The U.S. Department of Energy and the U.S. Environmental Protection Agency have, through the Energy Star Program, committed their institutional resources to ensuring the active participation of industry. However, the standard will be voluntary – no company will be required to use it – and can be adhered to entirely or partially by manufacturers. This allows gaining the benefits of a standard while retaining flexibility for manufacturers that believe that they can improve on the interface, or have a product with unique or unanticipated features.

Contract Number: 500-98-032

Contractor: Lawrence Berkeley National Laboratory (LBNL)

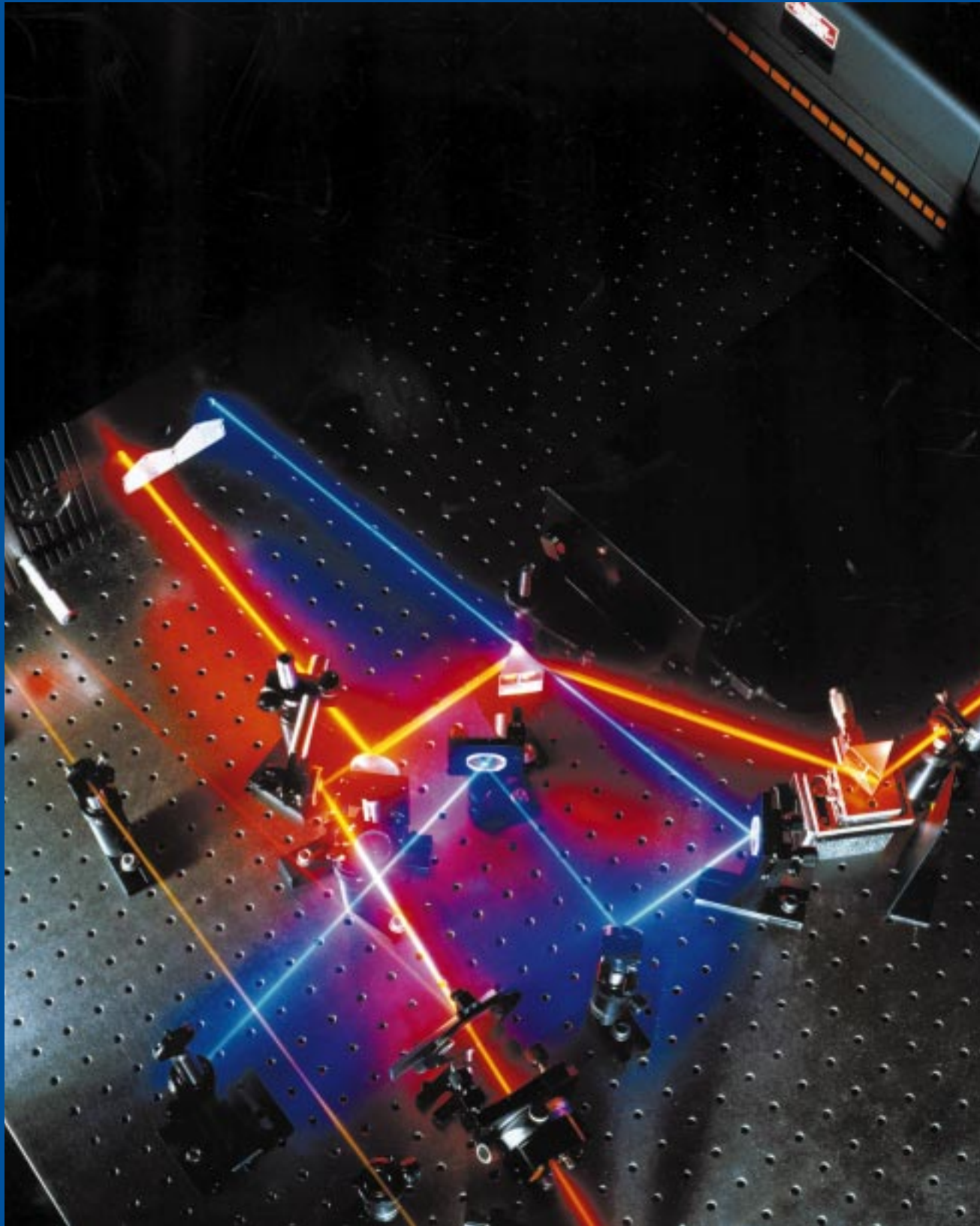
Contract amount: \$449,841

LBNL Project Manager: Alan Meier (510) 486-4740

CEC Contract Manager: Joseph Wang (916) 654-4026

INDUSTRIAL/AGRICULTURAL/ WATER END-USE ENERGY EFFICIENCY PROJECTS

Photo credit: Coherent Inc., Laser Group, Courtesy of NREL PIX



T Project Title: Integrated Agricultural Technology

The goal of this project is to demonstrate energy-efficient and environmentally friendly technologies that will help enhance the competitiveness of the agricultural sector. Issues such as water-use and wastewater treatment will be addressed along with alternatives for preparing and preserving food. This project supports the PIER program objective of improving the energy cost/value of California's electricity and impacting local and state economies by improving productivity, mitigating toxic chemicals and reducing energy consumption and water usage in the agricultural sector.

Specifically, this project will demonstrate:

- ozone as a substitute fumigant for methyl bromide in insect control on fresh and dried fruits and vegetables;
- ozone as an alternative to aqueous toxic chemicals for fungi control in fruit packaging operations;
- low-temperature, controlled ventilation in storage facilities for insect control of stored prunes;
- innovative manure treatment technologies for control of odorous gas emissions and nutrient discharge; and
- irrigation scheduling system to optimize yield of fruit orchards while reducing water and energy consumption.

The project will provide solutions to the problems of:

- short shelf-life of post harvested fruits from insect and fungi infestation;
- environmental pollution from dairy operations; and
- excessive water consumption and inefficient irrigation practices.

In addition, the project will replace well over 4000 tons of methyl bromide, an ozone depleter, by using ozone for fumigation of durable and perishable commodities; help reduce energy and water consumption by irrigation scheduling (a 20 percent reduction in water used for irrigation could save 780,000 acre-ft per year translating

into a water saving of \$78million/yr); and could conserve 25 million kWh/yr of electricity.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract amount: \$320,000

ETS Project Manager: Lory Larson (626) 815-0520

CEC Contract Manager: Ricardo Amon (916) 654-4019

T Project Title: UV Printing on Plastics

The goal of this project is to develop and test a six-color ultraviolet (UV) commercial printing system as an affordable and energy-efficient alternative to the traditional solvent-based ink printing process. The UV printing process will also allow commercial printing facilities in the South Coast Air Quality Management District (SCAQMD) to meet current air quality regulations. This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing an energy-efficient alternative to solvent-based ink drying processes. This project also supports the PIER program objective of having direct impacts on local and state economies by reducing, or even eliminating, the Volatile Organic Compound (VOC) emissions associated with solvent-based ink while maintaining the quality of the product. Consequently, this will improve the competitiveness of commercial printing operations in the SCAQMD.

Printing operations in Southern California must mitigate the use of solvent-based inks to comply with SCAQMD rule 113-0. Currently, these customers have four alternate choices. They may use water-based inks, which result in loss of quality and, consequently, customers; add expensive VOC control devices to their existing operation; move their business out of state; or close their operations, both of which result in a loss for California.

Edison Technology Solutions (ETS) will initially develop and conduct a pilot test of a one-color UV printing system on plastic bags and then demonstrate the benefits and viability of a commercial six-color UV printing system.

The advantages of UV printing are that it contains little or no VOCs, has excellent quality, is very high speed and

requires less space and drying energy. A feasibility assessment has shown that UV printing is the lowest cost option that complies with air quality Rule 1130 (SCAQMD) that mitigates the use of solvent-based inks.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract amount: \$250,000

ETS Project Manager: Mazen Sadeq (626) 815-0513

CEC Contract Manager: Ellie Townsend-Smith (916) 654-4170

¹Project Title: Low Dross Aluminum Melter

The goal of this project is to demonstrate the economic, environmental, energy efficiency and waste reduction benefits of the DC plasma arc low-dross aluminum melter technology comparing it to the reverberatory-furnace method currently used to melt aluminum. (Dross is the waste product or impurities formed on the surface of molten metal during smelting.) This project supports the PIER program objectives of improving the energy cost/value and improving environmental and public health costs/risk of California's electricity by reducing the California secondary aluminum industry losses of between \$500 and \$1000 million/year in wasted aluminum, and the emissions treatment and waste disposal costs from using the reverberatory-furnace aluminum melter method.

The reverberatory furnace has relatively low energy efficiency, high emissions, and a large waste stream. A new DC plasma arc melting technology is being tested by Edison Technology Solutions (ETS) at the one-ton/hour size in Fontana, CA. The process melts the aluminum in a stable and inert plasma medium (argon). This maintains a non-oxidizing environment, minimizing the loss of aluminum and emissions volumes.

Bringing the DC plasma arc melting technology to commercialization will improve the aluminum melting industry's competitiveness, foster energy efficiency, and reduce waste at the source. Many barriers exist before the technology is widely accepted in the industry. One of the

barriers is that the capital cost is three times that of the reverberatory furnace. In addition, the industry is reluctant to invest in this new technology until it is commercially proven. The challenge is to demonstrate the competitiveness of this innovative technology to the industry at the commercial size of five-ton/hr.

There are more than 1000 melters nationwide. They suffer high cost and stringent environmental regulations. This project delivers an innovative technology that solves operational and environmental challenges. For California, the technology will annually save melters \$100 million, bring \$23 million/year in economic benefits, create 1000 new jobs, and add \$4 million in tax revenues.

ETS proposes to commercialize this technology by leveraging lessons learned from the one-ton demonstration. ETS plans to build a pre-commercial five ton/hr melter to demonstrate the economic viability of this technology.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract amount: \$450,000

ETS Project Manager: Mazen Sadeq (626) 815-0513

CEC Contract Manager: Dennis Fukumoto (916) 653-6222

²Project Title: Recycling Chiller-Bath Rinse Water in Poultry Processing

The goal of this project is to reduce the energy required in poultry processing by demonstrating the feasibility of using ozone water treatment technology to recycle chiller bath rinse water in poultry processing operations. Presently, poultry processors use chlorine chemicals to disinfect the chiller-bath step and must discard the 0.5 gallons of chilled, chlorinated rinse water used per bird to meet USDA sanitary regulations.

This project supports the PIER program objective of improving the energy cost/value of California's electricity to electric ratepayers by reducing energy use or improving energy efficiency in the industrial sector. In addition, this project supports the PIER program objective of improving environmental and public health costs/risks of California's electricity by avoiding the use of chlorine disinfectants.

Using the Mobile Treatment Demonstration Unit (MTDU) provided by EPRI, a feasibility test at the Foster Farms Poultry Processing Plant in Livingston, California will demonstrate that ozone is an effective antimicrobial sanitizer in poultry processing which can be safely used in direct contact with the birds and that ozone does not create any harmful by-products or side effects. Upon obtaining U.S. Department of Agriculture (USDA) approval for a pilot-test program, WaterTech partners will design, install and operate a closed-loop, ozone-based pilot recycling system on the Foster Farms poultry processing chiller line for six months. Successful pilot-scale testing is expected to result in USDA approval for replacing chlorine with ozone in the chiller-bath process of the poultry-processing industry.

The WaterTech project will achieve energy savings by returning the filtered and disinfected chiller-bath overflow water to the heat exchanger used to chill water for the chiller bath. Since the average temperature of the feed water will be reduced to about 50°F from 75°F, the refrigeration load will be dramatically reduced — which will lower overall system energy requirements. This new process will be able to achieve estimated net energy savings of 3 million kWh per year of energy (about 12 watts/bird) in the 250-million-bird-per-year poultry processing industry in California.

This net energy savings is obtained by subtracting the 2 million kWh per year *increase* in energy use for producing ozone and operating the membrane filtration equipment (about 8 watts/bird) from the 5 million kWh per year *decrease* in refrigeration load (about 20 watts/bird) that can be achieved by recycling 80% of the chiller-bath overflow rinse water. At a deregulation industrial customer rate of about \$0.065 per kWh, the projected industry-wide savings in energy costs as a result of this new process will be about \$200,000 per year. These cost savings could increase to over \$1,000,000 per year if poultry producers find it necessary to increase their chiller-bath rinse-water makeup requirements from 0.5 to 2.5 gallons per bird to comply with HACCP procedures.

Contract Number: 500-98-030

Contractor: WaterTech Partners

Contract amount: \$440,400 Matching funds: \$144,000

*WaterTech Partners Project Manager: Ronald Enzweiler
(925) 283-4918*

CEC Contract Manager: Ricardo Amon (916) 654-4019

RENEWABLE ENERGY TECHNOLOGY PROJECTS

Photo credit: Warren Gretz, Courtesy of NREL PIX



Project Title: Photovoltaic (PV) Chargeport Demonstration

The goal of this project is to demonstrate the integration of electricity-generating photovoltaic (PV) panels into a covered parking port to charge electric vehicles. This one-of-a-kind application of PV will illustrate how the panels can be integrated into the current electrical system for practical applications. This project supports the PIER program objective of improving environmental and public health costs/risks of California's electricity by providing a clean source of electricity for zero-emission vehicles.

This project will demonstrate how two PV-covered parking systems that provide grid support and electric vehicle charging, while addressing the issues surrounding interconnectivity. The technical objective of this project is to develop experience with the proper installation and operation of triple-junction photovoltaic roofing panels for these types of applications.

The application of PV panels for many uses is well established; however, the design methods and applicability of triple-junction PV panels for electric vehicle charging is not. The demonstration and field testing of current design methodology will establish guidelines for future deployment of PVs for electric vehicle charge stations without the need for extensive engineering.

Development, installation, field testing and performance monitoring of the chargeports will take place in San Diego. The project will be completed by October 1999. The initial prototype design developed for the field test demonstration will become an off-the-shelf design after field test data are used to develop a final, modified design. This will result in chargeport system design cost reductions that will increase the number of chargeport installations.

Contract Number: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$90,000

SDG&E Project Manager: Sally Wirsching (619) 654-8269

CEC Contract Manager: Jamie Patterson (916) 654-4819

Project Title: Photovoltaics

The goal of this project is to operate and monitor several photovoltaic (PV) systems to evaluate their year-round performance and efficiency. This project supports the PIER program objective of improving the environmental and public health costs/risks of California's electricity by helping commercialize a clean electrical generation technology. This project also supports the PIER program objective of improving the reliability/quality of California's electricity because PV offers an attractive, environmentally benign alternative for distributed electrical generation.

This project provides support to Edison Technology Service's (ETS) Solar Neighborhood Program by helping to commercialize photovoltaic technology, educate and increase public awareness, and deploy photovoltaics into high-value, high-visibility applications. The program includes:

- **Photovoltaics (PVs) Grid Support/Reliability:** Instead of building new transmission/distribution lines where extra electricity is needed, ETS supports the installation of solar-PV systems. Projects include a 115 kW system at the Monterey Hills School in South Pasadena and a 100 kW system at the Huntington Library in San Marino.
- **Education and Multiple-Use Facilities:** ETS provides installation of solar-PV systems in schools, introducing the technology to students, serving an educational purpose and bringing added value to the system. At the Alamos Intermediate School in Garden Grove and at the University of California Campus in Irvine, solar panels are used to generate electricity for the schools and shelter the outdoor lunch area.
- **Public Awareness and Community Acceptance:** ETS is continuing efforts to increase public awareness and community acceptance by the deployment of PVs at high profile sites. Among other high-profile sites, ETS has installed systems at Knott's Berry Farm amusement park in Buena

Park, at the Santa Monica Pier to power the Ferris Wheel, and at universities with high visibility.

- **Implementation of Standardized Packages:** Significant cost reductions can be realized through standardization of material and installation procedures. Significant mass commercial deployment, standardization of products and consistent methodology towards program management are critical success factors in reducing the installed cost of PVs.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$1,000,000

ETS Project Manager: Steve Taylor (626) 815-0530

CEC Contract Manager: Jamie Patterson (916) 657-4819

Project Title: Solar Two

The goal of this project is to complete testing and evaluation of the Solar Two Central Receiver Project that uses solar energy to produce steam for electrical generation. Solar Two is a proof-of-concept project that will provide environmentally sound, zero-emission solar-thermal central receiver electrical generation. This project supports the PIER program objective of improving the environmental and public health costs/risks of California's electricity by proving a zero-emission electrical generation. This project also supports the PIER program objective of improving the reliability/quality of California's electricity by diversifying our electrical generation resources.

This project will complete testing and evaluation of the 10 MW Solar Two Central Receiver Project. This \$50 million project is co-funded by a collaborative of six electric utilities, the Electric Power Research Institute, three industrial firms, the South Coast Air Quality Management District, the U.S. Department of Energy, and the Energy Commission.

Solar Two is one-tenth the size of a plant capable of commercial operation. It consists of a circular field of heliostats to collect and focus the solar radiation on a receiver which is mounted on a tower standing within the

heliostat field. A fluid circulates through the receiver, collecting the thermal energy at 1050 degrees F, afterwards flowing to an insulated "hot" storage tank. Steam for the 10 MW turbine is made as needed by pumping some of the hot fluid to a heat exchanger. Having given up thermal energy to make steam, the fluid, now cooled to 550 degrees F, flows to a "cold" storage tank for recirculation to the receiver. Thermal storage, from energy inlet to energy outflow, is 98 to 99 percent efficient.

The receiver/energy storage fluid is a commercial molten potassium and sodium nitrate mix used in industrial applications. It is chemically stable at the Solar Two operating temperature, is not flammable, and is no more toxic than table salt in the event of a spill. The Solar Two plant demonstrates the use of molten salt both as a receiver and energy storage fluid for the first time in an operating solar-electric generation station.

Many design and operating lessons have been learned in the course of operating the plant. Some of the lessons have required that the plant be taken off line while specific equipment was being modified. In this manner, Solar Two has also served the function of being a research and development test bed. Each of the lessons learned and plant modifications carried out to improve operations is being documented in a final report to the collaborative, including the Commission.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions

Contract Amount: \$1,200,000

ETS Project Manager: Bill Stoke (909) 394-8986 ext.47986

CEC Contract Manager: Alec Jenkins (916) 654-4597

Project Title: Solar Dish/Stirling

This project was cancelled in November 1998 when it was determined that it would be impossible to procure a solar dish and operate it for one continuous year before the expiration of the Targeted Technology's agreement expiration date of June 30, 2000.

The goal of this project was to advance the use of solar dish/Stirling engine systems through hybrid operation in a natural gas-fuel burning mode that will reduce the levelized cost of this technology and bring it closer to full competitive commercialization. This project supports the PIER program objective of improving the reliability/quality of California's electricity by providing for the development of a renewable distributed resource electric-generating technology.

Solar Dish/Stirling technology is one of the most advanced technologies for grid-connected solar power. The solar dish currently can convert sunlight to electricity at a power conversion efficiency of 29.4 percent.

Contract number: PIER Transition Project Contract 500-97-012 (project nine) and Targeted Technology Contract 500-93-030

Contractor: Edison Technology Solutions (ETS)

Contract amount: \$430,000

¹Project Title: Powertherm, A Photovoltaic/Thermal Hybrid Commercial Roofing System

The goal of this project is to design a solar thermal component to add to Powerlight Corporation's PowerGuard® Photovoltaic (PV) roof top electric generating system. This design will increase the value of photovoltaic (PV) products by capturing thermal energy in addition to generating electricity. This project supports the PIER program objective of improving the reliability/quality of California's electricity by developing a distributed-energy technology. It also supports the PIER program objective of improving environmental and public health cost/risks of California's electricity by deploying a renewable energy source, which does not emit NO_x (nitrous oxides), SO_x (sulfur oxides), and CO₂ (carbon dioxide) when generating electricity.

The purpose of this contract with Powerlight Corporation is to develop and test its commercial photovoltaic/thermal solar collector system. Powertherm™ is a rooftop photovoltaic (PV) system providing both electrical power and thermal energy from sunlight.

Powertherm™ combines a heat collection system with the PowerGuard®, the leading PV roof system for large, low sloped roofs on commercial buildings.

Powertherm™ is suitable for buildings with flat to moderately sloping roofs. The PowerGuard® product was substantially advanced under a product R&D contract with the Commission's Energy Technologies Advancement Program (ETAP) and has been successfully fielded in dozens of applications internationally. PowerGuard® incorporates state-of-the-art PV technology which is backed with extruded polystyrene foam. These roof tiles are applied unadhered over built-up, mechanically attached or fully adhered membranes. The panels are electrically interconnected to an inverter that feeds utility-quality AC power to the building's electrical system. This technology can be integrated into new and re-roofing projects, or readily applied over existing roofs.

This project will advance the concept of solar PV combined with solar thermal energy (PV/T) collection into a marketable technology.

This project will:

- develop and advance design of tile construction, overall systems;
- complete system simulations;
- fabricate and test production prototype;
- design, fabricate and test scaleable systems; and
- complete product testing, acceptance and certification process.

Contract Number: 500-97-046

Contractor: Powerlight Corporation

Contract amount: \$542,362 Match funding: \$1,052,361

Powerlight Corporation Project Manager: Thomas Dinwoodie (510) 540-0550

CEC Contract Manager: Arnie Ward (916) 657-4630

¹Project Title: Residential Electric Power Security

The goal of this project is to design, assemble, and test a photovoltaic (PV) electricity producing power system for

residential rooftops. This PV energy system will be low-cost to manufacture and install while being highly reliable and energy efficient. This project supports the PIER program objective of improving the reliability and quality of California's electricity by developing a renewable energy technology for on-site electrical generation and storage. It also supports the PIER program objective of impacting California's state and local economies by increasing California's PV system production and installation capacity.

The purpose of this contract with Utility Power Group, Inc. (UPG) is to develop and test a low-cost, highly reliable, multi-functional residential rooftop photovoltaic (PV) power system. The major technical challenge to widespread use of rooftop photovoltaics for residential use is to reduce the installed costs and improve the reliability of small rooftop PV power systems. In many ways, the reliability of residential PV systems is more important than the cost if PV power systems are perceived by the public to be unreliable. The reliability of small PV is essential because the failure of a small system will result in a total loss of output.

Since 1992, UPG has engineered and constructed over 2 megawatts of grid-connected PV power systems. This project combines all that has been learned by UPG about component manufacturing and system integration into a singular focus on reducing the cost and increasing the reliability of rooftop PV power systems. The proposed rooftop PV power system will represent a more advanced version of UPG's PV technology and will possess market-driven capabilities that do not exist in any commercially available power processing product. If successful, this project plans to reduce the installed cost of grid connected rooftop PV power systems by at least 34 percent and improve their reliability factor by 5.

Contract Number: 500-97-047

Contractor: Utility Power Group, Inc. (UPG)

Contract amount: \$426,343 Match funding: \$994,799

UPG Project Manager: Rick West (805) 543-4520

CEC Contract Manager: Shabid Chaudhry (916) 654-4858

¹Project Title: Development of an Extended Induction Logging Tool for Geothermal Exploration and Field Development

The goal of this project is to develop a tool for discovering and mapping subterranean geophysical features that will be used to assess a location's potential for electricity-producing geothermal power. Developing the Geothermal Borehole Induction Logging Tool (GEO-BILT) supports the PIER program objective of improving the cost/value of California's electricity by enabling geothermal prospectors to define locations in the earth's crust with the potential for commercial geothermal resource development. Using the GEO-BILT should enable geothermal developers to drill fewer wells to achieve the same productivity from their fields, thus reducing energy costs by reducing drilling costs. This project also supports the PIER program objective of improving the reliability/quality of California's electricity by helping to identify where to place in-state geothermal power plants, which will diversify California's electricity supply mix.

The purpose of this contract with Electromagnetic Instruments, Inc. is to develop and test an extended logging tool for geothermal exploration and field development. Inductive resistivity logging is an important technology to geothermal producers because of the sensitivity of electrical resistivity to geological structure and variations in reservoir fluids. Electrical resistivity data from well logs is used in the geologic description of reservoirs. Commercially available logging tools of this type are not made to withstand the hostile, high-temperature environment in geothermal boreholes.

This project will also develop computer software to invert Geothermal Borehole Induction Logging Tool (GEO-Built) collected data and use it to provide a fracture model of a volume of rock surrounding a borehole. Fracture mapping is a critical need in geothermal field development because fractures play an important role in accessing and producing geothermal reservoirs. Locating, orienting, and

assessing producing fractures can guide drilling programs and optimize the placement of production and injection wells. This results in fewer dry holes and improved production in successful holes, substantially reducing cost and time infield development. There are no commercial logging tools to fill this need.

This project will provide a solution to the need for formation evaluation, reservoir delineation and a mapping tool for the geothermal industry. Economic benefits include the establishment of new logging services for the geothermal industry and the enhancement of geothermal exploration efficiencies.

Contract Number: 500-97-034

Contractor: Electromagnetic Instruments, Inc.

Contract amount: \$1,380,709 Match funding: \$1,407,953

Electromagnetic Instruments, Inc. Project Manager: Michael Wilt (510) 232-7997

CEC Contract Manager: Dr. Val Tiangco (916) 654-4664

¹Project Title: Hybrid Solar-Fossil Thermophotovoltaics

The goal of this project is to develop, manufacture and demonstrate a pre-production prototype Solar-Fossil Thermophotovoltaic (SFTPV) cogeneration power system. This project supports the PIER program objective of improving the reliability/quality of California's electricity by developing a new distributed generation technology. It also supports the PIER program objective of reducing the environmental impacts of electricity production through partial use of solar energy, a renewable and non-polluting energy source.

EDTEK, Inc. will design, fabricate and test a modular, hybrid solar/fossil-fueled thermophotovoltaic (SFTPV) system that can produce electricity and process grade hot water 24 hours per day with a recovery efficiency of about 83 percent. In this system, highly concentrated sunlight is directed into a cavity whose surrounding walls are heated to incandescence, the state where visible light is emitted from a hot object. This incandescent radiation then excites the PV cells that produce at 25 percent overall efficiency. A

natural gas flame is also directed into the cavity to heat its walls and excite the PV cells, as does the concentrated sunlight. The natural gas-to-electric conversion efficiency is about 17.5 to 20 percent.

By recovering waste heat in hot water, the natural gas burned by the SFTPV offsets gas that would normally be burned on the site for water heating and does not add additional atmospheric emissions. Thus, the capital investment in the PV array is utilized full time and the need for storage batteries is eliminated.

The specific economic obstacles which this project seeks to overcome are: 1) the high initial cost of fabricating PV cells; 2) the limited capacity factor for PV equipment (i. e., sunlight is only available about 25% of the time); and 3) the expense, maintenance and disposal of PV energy storage batteries.

Contract Number: 500-97-048

Contractor: EDTEK, Inc.

Contract amount: \$867,945 Match funding: \$1,917,107

EDTEK Project Manager: W. Ed Horne (253) 395-8084

CEC Contract Manager: Prab Sethi, P.E. (916) 654-4509

¹Project Title: PowerWheel Demonstration Project

The goal of this project is to prove the full-scale technical, economic and environmental suitability of the PowerWheel hydroelectric energy technology for conversion of the presently wasted renewable energy available in very low-head waterfalls into electricity. This project supports the PIER program objectives of improving the energy cost/value of California's electricity by reducing the average cost of hydroelectric generation by approximately 73 percent. The project also supports the PIER program objective of improving the reliability/quality of California's electricity by using a more predictable renewable energy source than solar or wind. Lastly, the project supports the PIER program objective of improving environmental and public health costs/risk of California's electricity by displacing approximately 250 tons of exhaust gases per year per kilowatt of PowerWheel installations.

The purpose of this contract with Powerwheel Associates is to develop and demonstrate a 75 kW low-head hydroelectric renewable energy technology with overall total system efficiency from water to wire of 65-70 percent. The PowerWheel technology can be located site-specifically on irrigation systems and natural streams with between 6 and 15 feet of water level difference between upstream and downstream of a dam or check structure. The electricity produced will be used in nearby agricultural, industrial, commercial or residential activities. The power range of the project is anticipated to be between 50-500 kW.

The successful completion of the project will provide the following benefits:

- reduced cost of electricity by avoiding the need for transmission from central stations;
- increased reliability due to avoiding outages caused by transmission line breakdowns; and
- elimination of pollutant discharge to the atmosphere of 250 tons of exhaust gas per year per kW capacity.

Contract Number: 500-97-037

Contractor: Powerwheel Associates

Contract amount: \$200,000 Match funding: \$200,000

Powerwheel Associates Project Manager: Kenneth Broome (650) 529-1810

CEC Contract Manager: Shabid Chaudhry (916) 654-4858

¹Project Title: Powerguard® PV System, Advanced Manufacturing Development and Scale-Up

The goal of this project is to expand grid-connected markets for the PowerGuard® electricity-producing, roof-mounted photovoltaic (PV) system by reducing component- and system-manufacturing costs, enhancing system reliability, and obtaining specific certifications. Furthermore, this project will establish a new California manufacturing facility using the automated and semi-automated fabrication innovations developed under this contract.

This project supports the PIER program objective of improving the reliability/quality of California's electricity system by developing a renewable distributed-energy technology. It also supports the PIER program objective of reducing environmental and public health costs/risks of California's electricity system by deploying a renewable energy source which does not emit nitrous oxides, sulfur oxides, and carbon dioxide when generating electricity. Lastly, this project supports the PIER program objective of impacting local and state economies by creating new manufacturing jobs.

The purpose of this contract with Powerlight Corporation is to develop manufacturing methods for a roof tile photovoltaic (PV) product. PowerGuard® is a rooftop PV system providing electrical power from solar energy. The PowerGuard® roofing assembly helps building owners lower utility bills while providing a thermal barrier that insulates the roof and protects the roofing membrane. This technology is suitable for buildings with flat to moderately sloping roofs. PowerGuard® incorporates state-of-the-art PV technology backed with extruded polystyrene foam. These roof tiles are applied unadhered over built-up, mechanically attached or fully adhered membranes. The panels are electrically inter-connected to an inverter that feeds utility-quality AC power to the building's electrical system. This technology can be integrated into new and re-roofing projects, or readily applied over existing roofs.

The PowerGuard® was substantially advanced under a product R&D contract (1995-97) with the Commission's Energy Technologies Advancement Program (ETAP) and has been successfully fielded in dozens of applications internationally. Significant cost reductions and market growth can now be realized through innovations in manufacturing, the focus of this agreement.

Contract Number: 500-97-049

Contractor: Powerlight Corporation

Contract amount: \$958,991 Match funding: \$1,994,421

Powerlight Corporation Project Manager: Thomas Dinwoodie (510) 540-0550

CEC Contract Manager: Arnie Ward (916) 657-4630

¹Project Title: Next Generation Wind Turbine Development Project

The goal of this project is to design, develop and demonstrate a 350 kW rated-capacity wind turbine that will produce electricity at prices that do not need subsidies or premiums to compete in the emerging electricity marketplace. This project supports the PIER program objective of improving the energy cost/value of California's electricity by producing renewable energy at prices competitive with the lowest cost sources of conventional electricity generation. It also supports the PIER program objective of improving environmental and public health costs/risk by helping reduce air pollution resulting from fossil-fuel electricity generation. Lastly, this project supports the PIER program objective of impacting local and state economies by the creation of new jobs in the wind energy industry and new tax revenues.

The purpose of this contract with The Wind Turbine Company (WTC) is to design, develop and demonstrate a 350 kW rated-capacity wind turbine with flexible rotors and tower that will produce electricity at prices that are competitive in the emerging electricity marketplace without subsidies or premiums. In addition to the U.S. Department of Energy (USDOE) and the National Renewable Energy Laboratory (NREL), WTC's collaborators include Sandia Laboratories, the Electric Power Research Institute (EPRI), Parsons Corporation and Edison Technology Solutions (ETS).

The full range of RD&D tasks include preliminary design, detailed design (component development), final design (systems integration), fabrication and field-testing applied first to a proof-of-concept turbine, and, second, to the next generation turbine prototype, the commercial WTC 350. The specific economic objective of the project is to produce electricity for 3.5¢/kWh or less when installed in annual quantities of 100 units or more in windfarms featuring Class 5 wind resources (14-mph annual average wind speeds). WTC's lightweight design permits the use of taller towers to capture higher winds at higher

aboveground elevations and utilizes proprietary wind turbine rotor technology adapted from the helicopter industry.

Successful completion of the project will produce unsubsidized wind energy, an important source of affordable, clean, renewable energy to California's electricity customers. In addition, widespread use of the WTC 350 will bring new jobs and tax revenues to the state, cause a substantial reduction in air pollution derived from fossil-fuel electricity generation and help California become the world leader and exporter of this renewable power technology.

Contract Number: 500-97-032

Contractor: The Wind Turbine Company (WTC)

Contract amount: \$950,000 Match funding: \$6,935,733

WTC Project Manager: Lawrence W. Miles (425) 637-1470

CEC Contract Manager: Dr. Val Tiangco (916) 654-4664

¹Project Title: Natural Gas Co-firing in Biomass Fueled Boilers

The goal of this project is to develop and retrofit a low-NO_x natural gas co-fire burner technology onto two biomass-fired, renewable energy industrial boilers in California. Typically, biomass fuel has a high moisture content and highly variable quality, which reduces its electric-power cost competitiveness and increases its environmental-compliance costs. This project will determine whether firing a small amount of natural gas, typically less than 10 percent of total heat input, gives operators greater control over the combustion process, thereby avoiding the economical and environmental problems created by wet biomass fuel.

This project supports the PIER program objective of improving the reliability/quality of California's electricity by developing a method for improving the economics of grid-connected, distributed electricity generating biomass facilities. It also supports the PIER program objective of impacting local and state economies by preserving employment opportunities in rural areas where these biomass facilities are typically located. Lastly, this project

supports the PIER program objective of improving environmental and public health costs/risk by mitigating air quality impacts from biomass combustion by co-firing biomass with natural gas within an independently controlled combustion zone with high-temperature, turbulent mixing. The low NO_x feature is unique to California, and this demonstration should facilitate co-fire permitting at other biomass facilities.

The Gas Research Institute's (GRI) co-fire system uses dual, opposed, high-pressure drop burners retrofit on boiler sidewalls. The gas combustion zone with these burners mixes strongly with the biomass combustion products to enhance combustion and reduce emissions. Additional burner development is needed because the conventional co-fire burner uses rapid mixing and a high-temperature flame to penetrate and rapidly mix with the solid fuel combustion gases. These conditions are counter to those associated with low-NO_x operation. To decrease NO_x emissions, significant heat removal from the flame will have to occur as the flame develops across the furnace. Considerable testing is needed to determine the best balance between low Nox and effective co-fire benefits.

Following development, low-Nox co-fire burner systems will be retrofit to biomass boilers at Fairhaven Power in Eureka, California, and Burney Mountain Power in Burney, California. Testing will be performed to quantify low-NO_x performance and co-fire benefits. The project will conclude with the documentation of burner design, operation, and application guidelines, and a business plan for technology transfer of the co-fire burner to the California biomass power market.

Contract Number: 500-97-040

Contractor: Gas Research Institute (GRI)

Contract amount: \$655,702 Match funding: \$731,784

GRI Project Manager: Robert Gemmer (773) 399-8313

CEC Contract Manager: Dr. Val Tiangco (916) 654-4664

¹Project Title: Design & Optimization of a Solar-Fired Double Effect Absorption Chiller

The goal of this project is to design and optimize a solar-fired, double-effect (2E) 20-ton absorption chiller that displaces conventional air conditioners with absorption equipment driven by solar energy and/or waste heat. This project supports the PIER program objective of improving the cost/value of California's electricity by reducing the consumption of, and the peak demand for, electricity. This project also supports the objective of improving environmental and public health costs/risks of California's electricity by reduced electricity demand when absorption chilling displaces conventional air conditioning. This is accomplished by a reduction in the air emissions associated with electric generation.

The most important component of a 2E, absorption chiller is the high-temperature generator. The main goal of this project is to optimize the design of the 2E absorption chiller by installing a water-fired, high-temperature generator, a shell and tube design with a six-inch diameter by five-foot long stainless steel shell installed vertically in the unit. The major tasks to be completed are: 1) the design, fabrication, and testing of enhanced shell and tube generators and alternate types of water-fired generators; and 2) the determination of the firing temperature/solution concentration/coefficient of performance (COP) relationship of the water-fired chiller.

Bergquam Energy Systems of Sacramento, California will develop a water-fired, 2E chiller that will operate efficiently at temperatures between 250-275°F. In particular, the 250°F temperature is important because devices that operate under this threshold are classified as low temperature water (LTW) devices. Significant cost reductions and operating simplifications occur for LTW equipment. The product will be a high-efficiency, competitively-priced, 2E water-fired absorption chiller that is optimized with regard to COP, cooling capacity and operating temperature.

The estimated amounts of benefits are determined by comparison to packaged, roof-mounted air conditioners with a peak demand of approximately 2.1 kW per ton. A solar absorption chiller has a demand of approximately 0.2 kW per ton. An 8,000-ft² commercial building with a cooling load of 20 tons would have the peak demand reduced by approximately 38 kW. The corresponding savings in electrical consumption would be approximately 39,000 kWh for the 8,000-ft² building.

Contract Number: 500-97-035

Contractor: Bergquam Energy Systems

Contract amount: \$150,000 Match funding: \$150,000

Bergquam Energy Systems Project Manager: Dr. Jim Bergquam (916) 383-9425

CEC Contract Manager: Prab Sethi, P.E. (916) 654-4509

¹Project Title: Power Conditioning Unit Test Center at PVUSA

The goal of this contract with the Sacramento Municipal Utility District (SMUD) is to develop a power conditioning/converting unit test center at the Photovoltaics for Utility Scale Applications (PVUSA) site in Davis, California. This project will address the need expressed by the photovoltaics community for a comprehensive third-party testing of power conditioning units, the part of a PV system that converts the array's direct current (dc) output into acceptable alternating current (ac) power. PVUSA will provide a facility for power conditioning unit (PCU) manufacturers to test their equipment on a long-term basis using PV systems tied to an actual distribution grid.

This project supports the PIER program objective of improving the reliability/quality of California's electricity by facilitating the integration of electricity from distributed generation technologies into the state's electricity transmission and distribution system. It also supports the PIER program objective of improving the safety of California's electricity by developing islanding detection capabilities. Islanding, the uncontrolled generation of electricity into a circuit thought-to-be de-energized,

threatens the safety of utility workers servicing transmission and distribution lines.

The PCU testing facility will provide reliable, verifiable third-party performance information on PCUs to PV customers under the Energy Commission's California Renewable Technologies Buy-down Program, the Federal Million Solar Roofs initiative and the Utility Photovoltaic Group's (UPVG) TEAM-UP.

The project will provide ongoing PCU device testing to:

- evaluate, enhance and apply the PCU test procedures being developed by Sandia National Laboratories and others for islanding detection;
- demonstrate the islanding detection schemes of multiple PCUs to utility engineers and involve them in determining appropriate tests and interconnection standards;
- develop, evaluate and apply performance test procedures to cover issues such as conversion efficiency, maximum power point tracking accuracy and output power quality; and
- develop and implement a certification procedure for PCUs and achieve becoming an accredited testing laboratory.

Contract Number: 500-97-050

Contractor: Sacramento Municipal Utility District (SMUD)

Contract amount: \$374,847 Match Funding: \$140,080

SMUD Project Manager: Dan Whitney (916) 732-5351

CEC Contract Manager: Jamie Patterson (916) 657-4819

²Project Title: Utilization of Waste Renewable Fuels in Boiler with Minimization of Pollutant Emissions

The goal of this project is to develop the Close-Coupled Gasification (CCG) energy technology, a hybrid combustion/gasification technology that utilizes low-grade biomass and waste fuels to reduce pollutant emissions in existing boilers. This project supports the PIER program objective of improving environmental and public health costs/risks of California's electricity by providing an environmentally-safe energy source that will utilize waste

products and decrease air pollutant emissions from stationary combustion sources.

The major advantage of the CCG technology is utilization of renewable waste fuels with simultaneous reduction of pollutant emissions. The CCG technology offers significant environmental benefits by providing both a cleaner method of waste disposal and a means for reducing combustion emissions. The gasified product can be used in existing boilers in co-firing, reburning and advanced reburning modes, providing 65-70 percent (in basic reburning) and up to 90 percent (in advanced reburning) reduction in NO_x. Substitution of fossil fuels with renewable fuels will also result in a reduction of net CO₂ emissions.

Contract Number: 500-98-037

Contractor: Energy and Environmental Research Corporation (EER)

Contract amount: \$981,952 Match funding: \$610,238

EER Project Manager: Dr. Vladimir Zamansky (949) 859-8851

CEC Contract Manager: Dr. Val Tiangco (916) 654-4664

²Project Title: Collins Pine Co. BCI Cogeneration Project

The goal of this project is to develop and demonstrate co-location of a biomass-to-ethanol (and other co-products) manufacturing facility with a biomass electric generator which can improve the economic viability of biomass power plants. This project supports the PIER program objective of improving the energy cost/value of California's electricity by obtaining value for a biomass facility's otherwise waste stream. This project also supports the PIER program objective of impacting local and state economies by the creation of new jobs and new tax revenues through multiple market products.

This project will develop an integrated renewable products system that can produce multiple market products, thereby increasing the revenue streams for existing or new biomass facilities. This project will accomplish this task by integrating a biomass power facility

into a multiple-product operation. Doing this gives the biomass-fired power facility the opportunity to:

- obtain value for its otherwise waste steam;
- sell its power to the thermal host facility;
- spread fixed infrastructure costs over a wider base of operations; and
- obtain access to a reliable source of high quality lignin boiler fuel from the host facility.

In addition, the thermal host facility gains access to steam, power, and existing infrastructure such as land, roads, buildings, and feedstock handling facilities, all of which reduce its capital and operating costs. When combined, both the biomass power facility and the thermal host are able to reduce their overall costs while increasing revenues from higher-value ethanol products and co-products.

Contract number: 500-98-043

Contractor: Collins Pine Company

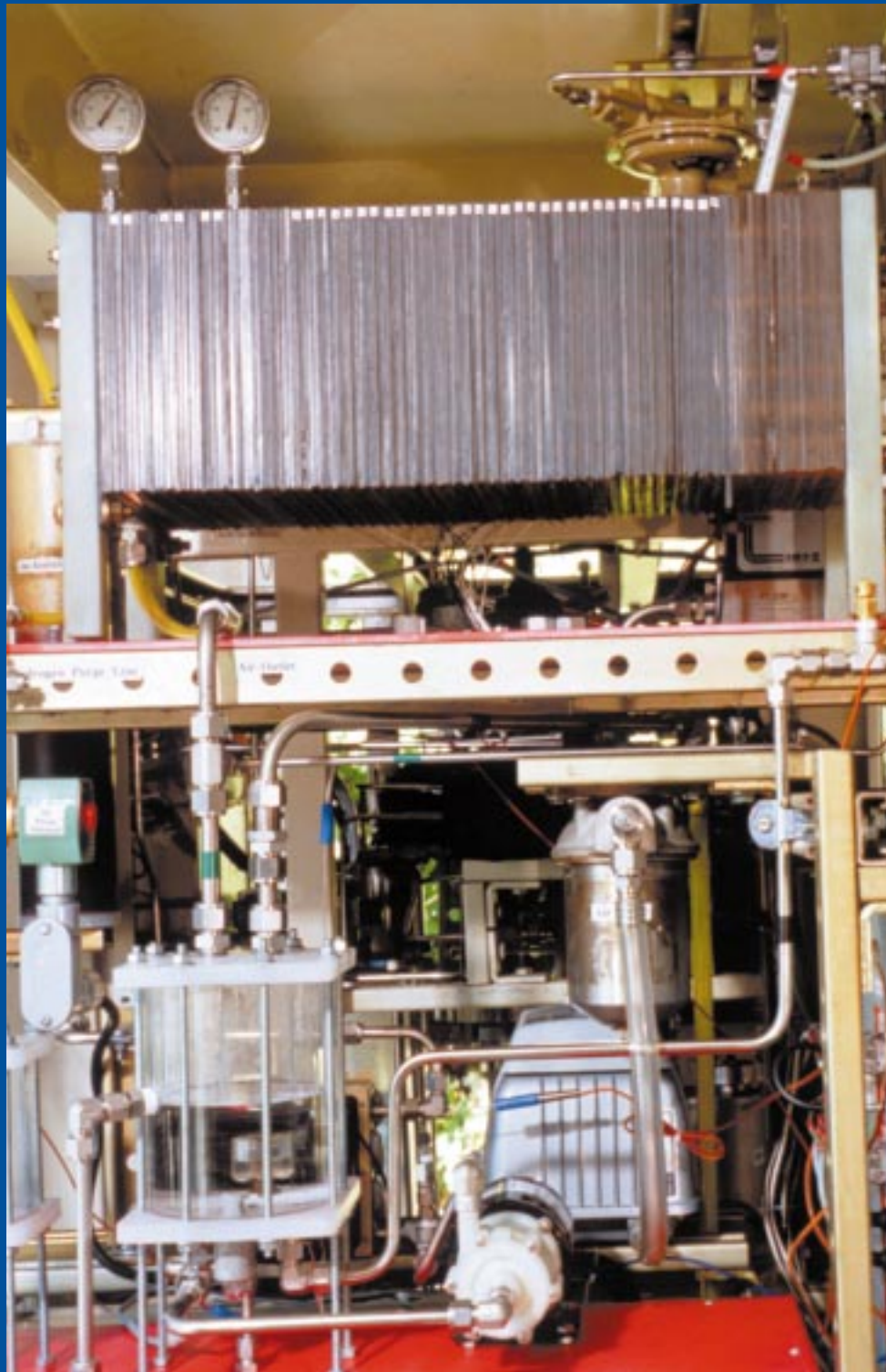
Contract amount: \$1,149,961 Match Funding: \$382,274

Collins Pine Company Project Manager: L.W. Potts, Jr. (530) 258-2111

CEC Contract Manager: Dr. Val Tiangco (916) 654-4664

ENVIRONMENTALLY- PREFERRED ADVANCED GENERATION PROJECTS

Photo credit: Rudy Gillard, Chromogenics, Courtesy of NREL PIX



† Project Title: Solid-Oxide Fuel Cell/Micro Turbine Generation Hybrid

The goal of this project is to demonstrate the proof-of-concept testing for integrating two dissimilar electricity production distributed generation technologies – pressurized solid oxide fuel cell (PSOFC) and micro turbine generator (MTG) – into a 250kW hybrid unit. This project supports the PIER program objectives of improving the energy cost/value and environmental and public health costs/risk of California's electricity by providing reliable, diverse, energy-efficient, low-emission distributed electrical resources.

This project will support Edison Technology Solutions (ETS) participation in a \$16.9 million public/private sector collaborative project with the DOE, Siemens Westinghouse and the University of California, Irvine (UCI) where the technology will be demonstrated. This project will demonstrate a “first of a kind integration” of both technologies. While both technologies are separately nearing commercialization, their integration into a hybrid unit is expected to offer significant environmental and energy efficiency benefits. Further, it is expected that the mature, commercial hybrid units will be more competitive than stand-alone fuel cells and will provide the same level of clean power output.

The key technical issue requiring demonstration and development is the integration of the fuel cell with the MTG. The MTG compressor will pressurize the solid-oxide fuel cell with supply air enabling it to produce more power. The hot gases leaving the fuel cell will be expanded through the expander portion of the MTG. A recuperator will be used to recover the waste heat from the turbine exhaust and preheat the compressed air prior to entering the PSOFC.

Successful completion and utilization of this technology will result in air quality benefits through a reduction in NO_x and greenhouse gas emissions. The integrated, pressurized fuel cell and MTG hybrid will result in a 60% electrical efficiency generating device that

is equal to or greater than any other form of fossil-energy generation.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract amount: \$2,000,000 Match funding: \$14,900,000

ETS Project Manager: Stephanie Hamilton (626) 815-0514

CEC Project Manager: Dr. Avtar Bining

† Project Title: Distributed Resources Demonstration

The goal of this project is to demonstrate how small, fossil fuel-based distributed generation systems can be seamlessly integrated into existing electric distribution systems. Distributed generation will allow additional electric generation facilities to be installed without undertaking construction of large commercial power plants, and will provide backup for the current electrical distribution system. This project supports the PIER program objective of improving the reliability/quality of California's electricity by improving the integrity, reliability and safety of California's energy supply system through diverse distributed electrical resources. In addition, this project addresses electrical distribution issues raised by deregulation of the California electricity industry.

Current interconnection methods of small distributed resources require expensive safety devices and manual dispatching and control. New electronic control systems promise remote dispatching and control at greatly reduced cost from previous systems. Development and field testing of electronic interconnection and control systems in this project will assist in defining the required operating characteristics of controls for distributed resources. Standards can then be developed that will ensure the safety and reliability of the distribution system when distributed resources are connected.

This project will demonstrate and prove the usefulness and viability of integrating small, distributed generation into electrical distribution systems. Development, installation, fielding testing, and performance monitoring of the distributed resource and control system will take

place in San Diego. The project will be completed by October 1999. The initial prototype electronic control system design developed for the project will be used to develop standards for the operating requirements for general interconnection control systems. These standards will be used by distributed resource system designers to ensure that their distributed resource systems can be connected safely, reliably, and easily to the distribution system.

Contract Number: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$450,000

SDG&E Project Manager: Al Figueroa (619) 654-8614

CEC Contract Manager: Jamie Patterson (916) 657-4819

T Project Title: Formation of NO_x in Industrial Gas Burners

The goal of this project is to develop technologies (and associated scientific and applications-oriented knowledge) to attain and maintain energy-efficient operation of natural gas industrial burners and stationary gas turbines with ultra-low emissions of nitrogen oxides (NO_x). This project supports the PIER program objective of improving the environmental and public health costs/risk of California's electricity by maintaining the energy efficiency and ultra-low emissions achieved in natural gas industrial burners and stationary gas turbines.

The core component of this project will be a closed-loop combustion control with advanced sensors, including field applications applied to industrial burners and boilers. The high temperature and boiler elements of this project, funded by Southern California Gas, Maxon, and Coen, involve laboratory field testing and other technology transfer activities that interact synergistically with the core component.

Contract Number: 500-97-013

Contractor: California Institute for Energy Efficiency (CIEE)

Contract amount: \$335,000

CIEE Project Manager: Jim Cole (510) 486-4123

CEC Project Manager: Matt Layton (916) 654-3868

T Project Title: Fuel Cell Development and Demonstration

The goal of this project is to demonstrate the performance and reliability of a molten carbonate fuel cell (MCFC) electric generating technology with upgraded system components. Proving the efficiency and effectiveness of fuel cells will help propel this low-emission, electric generation technology into the marketplace. This project supports the PIER program objective of improving the reliability/quality of California's electricity by offering energy efficient, low-emission alternate sources of electricity that diversify the state's electrical generation resources.

This project will assist in the advancement of MCFC technology by providing labor and selected materials for modifying the existing balance-of-plant components designed for a 250 kW capacity MCFC demonstration plant at the Marine Corps Air Station Miramar. Balance-of-plant modifications are required to accept the next generation fuel cell stack having a capacity of 75 kW. An improved design of MCFC fuel cell stacks will be tested and demonstrated at the Miramar plant. Other system components, including a new hot gas blower and turbo charger, will also be tested. Additionally, an assessment of the technical feasibility of integrating micro-turbine generator technology with the MCFC technology will be done.

Contract Number: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$300,000

SDG&E Project Manager: Al Figueroa (619) 654-8614

CEC Contract Manager: Dr. Avtar Bining (916) 657-2002

T Project Title: Micro Turbine Generator (Distributed Generation)

The goal of this project is to test a small gas turbine in distributed electrical generation applications. This project supports the PIER program objectives of improving the reliability/quality and the energy cost/value of California's

electricity by offering alternatives for distributed generation applications that will reduce the costs of transmitting and distributing electricity. Additionally, this project supports the PIER program objective of improving the environmental and public health costs/risk of California's electricity by reducing NO_x emissions from on-site electrical generation. Lastly, this project supports the PIER program goal of impacting local and state economy by contributing information to help in developing an emerging distributed generation technology industry in California.

This project is part of a public/private sector \$2 million collaborative microturbine generator (MTG) transition procurement and testing project at the University of California, Irvine (UCI). The project partners include UCI, DOE, EPRI, and several MTG manufacturers.

This project will procure and test for the first time, small gas turbine technology in distributed generation applications. The MTG collaborative program consists of extrapolating the automotive MTG design into a long-life machine suitable for use as a land-based electric generation technology. Funding from the Commission's PIER program's transition project funding will fund the procurement and testing of two Bowman microturbine generators, a major element of this program. The MTG, which is typically rated in the 30-60 kW range, is a small combustion turbine that has an integral high-speed generator.

Successful completion of the MTG project will provide the following benefits:

- Enhance system reliability - MTGs can enhance system reliability benefits for California utility ratepayers by reducing T&D operating costs.
- Environmental - MTG usage will result in reduced NO_x emissions.
- Economic Development – This project will involve procuring MTGs from two California-based MTG manufacturers.

If successful, this project will contribute information to help in developing an emerging distributed generation technology industry in California.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$500,000 Match Funds: \$1,500,000

ETS Project Manager: Stephanie Hamilton (626) 815-0514

CEC Project Manager: Dr. Avtar Bining (916) 657-2002

¹Project Title: 75-kW Molten-Carbonate Fuel Cell Stack Verification Test

The goal of this project is to demonstrate the energy-producing performance of advanced design molten carbonate fuel cell (MCFC) stack components in a 75 kW electric power generator. This project supports the PIER program objective of reducing the environmental and public health costs/risk of California's electricity by developing an efficient electric generating technology that emits negligible levels of ozone and smog precursor pollutants and reduced levels of carbon dioxide. The project also supports the PIER program objective of improving California's electrical system reliability/quality by demonstrating fuel cell technology for distributed generation applications.

The 75 kW MCFC Stack Verification Test Project is an important step toward commercializing MCFC power generation technology in the year 2002. The test will be conducted at the existing test facility at Marine Corps Air Station Miramar in San Diego. Based on information from a prior Miramar test and small-scale factory tests, advances in fuel cell components and stack design have been identified. A new 75 kW stack will be built incorporating the advanced technology and will be installed at Miramar for testing. The specific goals of the project are to:

- verify the long term current density performance of M-C Power's most advanced stack design in full size cells under field conditions;
- evaluate the effect of anode recycle on generator performance; and

- gather operating data upon which to base the design of future commercial prototype generators.

The MCFC generator being developed promises to provide the following benefits:

- 50-80 percent higher efficiency than conventional combustion-type generators;
- negligible emissions of ozone and smog precursor pollutants;
- reduced production of carbon dioxide exceeding target of climate change initiatives;
- higher reliability of service – high-quality power, few moving parts, and no transmission lines;
- reduced consumption of fuel resources; and
- competitive cost of electricity

Contract Number: 500-97-039

Contractor: M-C Power Corporation

Contract amount: \$1,000,000 Match funding: \$1,956,841

Contract Project Manager: Thomas Benjamin (630) 986-8040, Ext. 159

CEC Contract Manager: Dr. Avtar Bining (916) 657-2002

¹Project Title: Low NO_x Gas Turbine Combustors for Distributed Power Generation

The goal of this project is to conduct the research and tests necessary to advance Alzeta Corporation's Surface Stabilized Combustion (SSC) technology for application in up to four commercially available gas turbine engines for distributed power applications. This project supports the PIER program objective of improving the energy cost/value of California's electricity market by reducing the cost for NO_x mitigation and reduction technology for small- and micro-scale gas turbines. This project also supports the PIER program objective of reducing environmental and public health costs/risk of electricity generation in California by achieving greater emissions reductions than currently required by law.

This contract with Alzeta Corporation will test a low NO_x combustor in gas turbines and turbine test cells. The

objective of this project is to continue the development of the Alzeta Surface Stabilized Combustor (SSC) for use in gas turbines. The project will result in field demonstrations in distributed power generators from 10 kW to 5 MW. Results to date in pressurized test facilities have demonstrated that the SSC is capable of achieving sub-2 ppm emissions of NO_x, CO and unburned hydrocarbons (UHC). Achieving these emissions levels without the use of a catalytic combustor or post-combustion controls such as selective catalytic reduction (SCR) will accelerate the proliferation of low-cost distributed power systems by eliminating the need for current costly methods of controlling emissions.

In this project, Alzeta will meet the following goals:

- Simultaneous NO_x, CO and hydrocarbon emissions under 2 ppm;
- Operation with preheat and pressure ratios consistent with an advanced recuperated gas turbine cycles;
- Operation on a range of fuels, liquid and gas; and
- Passive control requirements for safe, inexpensive and reliable operation.

To commercialize the turbine combustor package, Alzeta has assembled a team of gas turbine manufacturers who have agreed to provide detailed cycle and hardware configurations to establish combustor performance and configuration criteria. They have also agreed to perform tests at their respective turbine test facilities during the final phase of the project.

Contract Number: 500-97-031

Contractor: Alzeta Corporation

Contract amount: \$878,788 Match funding: \$675,000

Alzeta Corporation Project Manager: Dr. Scott Smith (408) 727-8282

CEC Contract Manager: Dave Hatfield, P.E. (916) 654-7119

¹Project Title: Ultra-High-Efficiency Packaged Microcogeneration System

The goal of this contract is to develop and demonstrate an ultra-high efficiency microcogeneration power system. This project will develop and demonstrate a microcogeneration system that will open new, high-value applications in which cogeneration has not previously been technically viable. This system will generate power at a cost well below benchmark electricity costs with overall efficiency of up to 95 percent and ultra-low emissions.

This project supports the PIER program objective of improving the energy cost/value of California's electricity by providing electricity at a projected 4.9¢ per kWh at 30 percent capacity factor and could be as low as 2.5¢ per kWh. This project also supports the PIER program objective of improving the environmental and public health costs/risk of California's electricity by producing significantly lower NO_x (approximately 90 percent lower) and less CO₂ (less than 50 percent) levels than a gas-fired central power plant.

In the initial packaged microcogeneration system, a small, low-cost combustion turbine replaces the burner of a conventional space-heating furnace. The turbine generates electricity at up to 9.8 kW and space heating is captured from the turbine exhaust using conventional furnace heat recovery techniques. Space heating is chosen as the initial application because it is one of the lowest-temperature heating applications, thus offering the potential for the highest possible efficiency in cogeneration. However, the same combustion turbine may replace the burner in other heating and absorption cooling systems in a similar fashion.

The principal advantage of Aero Vironment's approach to microcogeneration is that the incremental cost of incorporating the combustion turbine into a standard furnace (or other system) is very low, approximately \$250/kW. Additionally, the reliable turbine is expected to have low maintenance costs relative to reciprocating engines. This makes cogeneration economically attractive

in applications with capacity factors as low as 15-20 percent, opening a broad array of new applications.

Contract Number: 500-97-042

Contractor: Aero Vironment, Inc.

Contract amount: \$1,035,420 Match funding: \$425,319

Contract Project Manager: Alec Brooks (626) 357-9983

CEC Contract Manager: Shabid Cbaudbry (916) 654-4858

¹Project Title: A Novel Steam Reforming Reactor for Fuel Cell Distributed Power Generation

The goal of this project is to develop a less-costly process for producing small volumes of fuel cell-grade hydrogen from natural gas for use by electricity-producing fuel cells. This project supports the PIER program objectives of improving the reliability/quality, improving the environmental and public health costs/risks and improving the energy cost/value of California's electricity by advancing the use of low-emission, low-cost, distributed resource fuel cell technology.

The purpose of this contract with Energy and Environmental Research Corporation (EER) is to develop and evaluate catalysts and sorbents for a steam reforming process within fuel cell systems. EER will conduct research and development of advanced catalysts/absorbers and an advanced reactor design for the steam reforming of fossil fuels to produce hydrogen for use by fuel cells. The research will advance the development of EER's novel steam reforming process for small-scale (less than one million ft³/day) production of fuel cell grade hydrogen. When combined with proton-exchange membrane (PEM) fuel cells, the pollutant emissions from the reformer are approximately zero NO_x (0.01-ppm sensitivity limit), less than 10 ppm Carbon Monoxide (CO), and less than 50 ppm Methane (CH₄), all measured at 7 percent O₂. These numbers are substantially lower than the emissions from conventional steam generating power plants.

The key technical issue requiring research and development for this novel steam reforming process is the development of catalysts/absorbers with target lifetimes of

5,000 to 30,000 hours. Current catalyst/absorber lifetimes in the process are on the order of 1,000 hours, resulting in undesirable maintenance frequency intervals. Reducing maintenance by increasing catalyst/absorber lifetimes could have a dramatic impact on the cost of produced electricity, reducing it by as much as 30 to 40 percent. The project will involve both catalyst/absorber development and evaluation and reactor design efforts. The catalyst/absorber development effort will be paid for by Phillips Petroleum, while the catalyst/absorber evaluation will be paid for with CEC PIER funds. The reactor design effort - to build a functional pre-production prototype of a system which can produce 35-50 kWe from a PEM fuel cell using pipeline natural gas - will be supported by EER's current DOE program, with funding from the U.S. DOE and Edison Technology solutions (ETS).

Contract Number: 500-97-038

Contractor: Environmental Research Corporation (EER)

Contract amount: \$349,852 Match funding: \$303,458

Contract Project Manager: Jerald Cole (949) 859-8851

CEC Contract Manager: Dr. Avtar Bining (916) 657-2002

¹Project Title: Megawatt-Class Pressurized Solid Oxide Fuel Cell/Gas Turbine Power System Demonstration Project

The goal of this project is to prepare the preliminary design for a megawatt (MW)-class pressurized, solid-oxide fuel cell/gas turbine power system for generating electricity at commercial and small industrial sites. This project supports the PIER program objective of improving the reliability/quality of California's electricity by designing a distributed energy technology which can be located at or near load centers, thereby relieving transmission congestion during peak electrical demand periods. It also supports the PIER program objective of reducing environmental costs/risk by generating power quietly and with very low emissions from the on-site production of electricity.

Commercial natural gas-fueled MW-class pressurized, solid-oxide fuel cell/gas turbine (PSOFC/GT) power systems have the potential to offer significant benefits to ratepayers in California. High thermal efficiency (approaching 70 percent) together with low capital cost (approximately \$1000-\$1500/kWe) resulting from mass-produced, factory-assembled modular systems will reduce the cost of electricity by 20-30 percent compared to existing commercial and small industrial power system technologies.

Megawatt-class PSOFC/GT power systems will be environmentally friendly with virtually no SO_x emissions, less than 0.05 ppm NO_x, no CO emissions, no particulate emissions and low noise (less than 65 dBA at 5 meters from system boundary). The Phase 1 preliminary design work, partially funded by the Energy Commission, will be performed by Westinghouse Electric Company in parallel with a demonstration program sponsored by Edison Technology Solutions (ETS) for a 250 kWe PSOFC/Micro-Turbine Generator power system. Successful operation of the system will trigger the initiation of Phase 2 hardware demonstration.

The primary objectives of Phase 1 are to:

- develop a standard, fully-integrated, low-cost commercial prototype design using factory-assembled, skid-mounted components for the demonstration system that addresses those design issues unique to the MW-class PSOFC/GT system and which satisfies the requirements for the selected site;
- update the cost estimate for Phase 2; and
- develop a detailed project plan for Phase 2 and a preliminary Production Readiness Plan for future commercial units.

Contract Number: 500-97-045

Contractor: Westinghouse Electric Company

Contract amount: \$550,000 Match funding: \$550,000

Contractor Project Manager: Dr. Stephen E. Veyo (412) 256-1901

CEC Contract Manager: Prab Sethi, P.E. (916) 654-4509

¹Project Title: Durability of Catalytic Combustion Systems

The overall goal of this project is to conduct the research and development necessary to advance the Catalytica Combustion Systems, Inc., catalytic combustion technology for on-engine field testing in a 1.5 MW Kawasaki gas turbine engine. This project supports the PIER program's objective of improving the energy cost/value of California's electricity by creating a cost-competitive alternative to conventional NO_x mitigation and reduction technologies for gas turbines in all size ranges. The project also supports the PIER program objective of improving environmental and public health costs/risk of California's electricity by lowering electrical generation emissions. It also supports the PIER program objective of directly impacting state and local economies because the Contractor is a California corporation.

The purpose of this contract with Catalytica Combustion Systems, Inc. is to develop and demonstrate a catalytic combustion system capable of reducing the NO_x emissions from combustion turbines to a level of 3 ppm or less. This project will provide the needed advancements in science and technology to move catalytic combustion systems from research and demonstration to one step removed from commercial applications.

This project will benefit electric energy consumers by reducing the NO_x emissions from combustion turbines to 3 ppm or less. In preventing the formation of NO_x, the catalytic combustion system eliminates the solid and gaseous hazardous waste streams associated with selective catalytic reduction (SCR) technology. The spent SCR catalyst is hazardous, as is the slipstream of ammonia that is emitted to the atmosphere. In addition, gas turbine generating systems employing this advanced catalytic combustion system could, by eliminating the SCR, reduce the electricity production costs by \$0.05 cents per kWh. Because of the low emissions and reduced system cost, applications are likely in distributed power generation scenarios. Distributed power, made possible by the

introduction of catalytic combustion, has the potential for further reducing the cost of electricity. Gas turbine generation systems equipped with catalytic combustion systems will provide new standards for NO_x emission regulations.

Contract Number: 500-97-033

Contractor: Catalytica Combustion Systems, Inc.

Contract amount: \$1,316,303 Match funding: \$3,029,846

Catalytica Combustion Systems, Inc. Project Manager: Tom Morjig (650) 940-6371

CEC Contract Manager: Dave Hatfield, P.E. (916) 654-7119

¹Project Title: Energy Efficient, Low Emission, Cost Effective MicroPilot Ignited Natural Gas Engine Driven Genset for Deregulated, Distributed Power Generation Markets

The goal of this project is to develop and demonstrate a high-efficiency, low-initial-cost, low-operating-cost, low-emissions, natural gas engine for use in California's deregulated, distributed power generation market. This project supports the PIER program objective of improving the energy cost/value of California's electricity by introducing a low-cost generator set that produces electricity at 4.0¢ per kW-hr (levelized, life cycle electric costs). It also supports the PIER program objective of improving California's electrical-system reliability by deploying a cost-effective and environmentally benign distributed generation technology.

The Gas Research Institute (GRI) will continue the development of a new technology which takes advantage of the cost and emissions benefits of clean-burning natural gas, the fuel efficiency of modern diesel engines, the low, first cost of high-production diesel engines and the ease of installing distributed power with an internal combustion engine.

This technology is known as MicroPilot™ Diesel-Cycle Natural Gas Engines. This project will complete development of a 1- percent MicroPilot™ engine and demonstrate a production-ready version of the

MicroPilot™ technology applied to the Caterpillar 3412 diesel generator set engine. In addition to development and demonstration of this cost-competitive approach to distributed power generation, a concurrent effort to develop and optimize the lowest possible emissions is proposed. This technology is generic and will be offered to all interested engine manufacturers for commercialization. This technology can be applied to new engines or as a retrofit kit for existing diesel engines.

Contract Number: 500-97-041

Contractor: Gas Research Institute (GRI)

Contract amount: \$982,528 Match funding: \$250,000

Contract Project Manager: Lou A. Lautman (773) 399-5461

CEC Contract Manager: Shabid Chaudhry (916) 654-4858

²Project Title: Intelligent Software Agents for Control and Scheduling of Distributed Generation

The goal of this project is to improve system reliability and power quality in California's competitive energy industry by enabling a greater participation by owners of distributed energy resources (DER) through the use of intelligent software agents for control and scheduling of distributed generation. The California Alliance for Distributed Energy Resources (CADER) projects that DER technology could supply 20 – 40 percent of the estimated capacity that will be needed in California to both replace retired generating plants and to meet increased loads. This project supports the PIER program objective of improving the reliability/quality of California's electricity by reducing distribution system congestion and avoidance of distribution line losses.

Current interconnection methods of small-distributed resources lack the ability to be readily dispatched and remotely controlled. New electronic control systems using advanced software promise remote scheduling and control at greatly reduced cost from previous systems. Development of electronic scheduling and control software in this project will assist in defining the required operating characteristics of controls for distributed resources.

Development and testing of the scheduling and control software will take place in San Diego. The project will be completed by April 2000. The initial prototype software design developed for the project will be used to develop software standards for general scheduling and control software. These standards will be used by distributed resource software programmers to ensure that their distributed resource systems can be connected safely, reliably, and easily to the distribution system.

Contract Number: 500-98-040

Contractor: Alternative Energy Systems Consulting, Inc (AESC)

Contract amount: \$554,010 Match funding: \$59,543

AESC Project Manager: Gerald L. Gibson (619) 560-7182

CEC Contract Manager: Jamie Patterson (916) 654-4819

²Project Title: Catalytic Combustor - Fired Industrial Gas Turbine for Distributed Power and Cogeneration Application

The goal of this project is to develop an ultra-low NO_x catalytic combustion system for industrial gas turbines in distributed power and cogeneration applications.

This project supports the PIER program objective of improving environmental and public health costs/risk by bringing a combustion system to commercialization for industrial-scale gas turbines with 5 ppm or lower NO_x emissions and reduced CO and CO₂ emissions. In addition, this project supports the PIER program objectives of improving the energy cost/value and reliability/quality of California's electricity by lowering the cost of power generation due to reduced emissions compliance costs and lower transmission/distribution losses and providing a more reliable power infrastructure through distributed generation.

Initially, this project will focus on critical component development for two specific engine products, Solar Turbine, Inc.'s Centaur 50 (rated at 4.5 MW) and the Taurus 60 (rated at 5.2 MW) gas turbines. The components will be

tested at conditions simulating the engine environments for which they are designed.

In future work not covered by this contract, integrated combustor assemblies will be tested in rigs that simulate engine-operating conditions. Following successful rig tests, combustors will be fabricated for installation and testing in one of the subject Solar Turbines engines as a pathway to commercializing the technology.

Contract Number: 500-98-041

Contractor: Solar Turbines, Inc.

Contract amount: \$814,543 Match funding: \$773,391

Contract Project Manager: Dr. Ken Smith (619) 544-5539

CEC Contract Manager: Dave Hatfield, P.E. (916) 654-7119

ENERGY-RELATED ENVIRONMENTAL RESEARCH PROJECTS

Photo credit: Allen M. Jenkins - US Fish and Wildlife Service, Courtesy of NREL PIX



† Project Title: Regional Ambient Aerosol Study (RAAS)

The goal of this project is to allow PG&E to continue providing technical expertise to the California Regional PM10/PM2.5 (particulate matter in the 2.5 – 10 micrometer size range) Air Quality Study, which is headed by the Air Resources Board. Particulate matter (PM) in the 2.5 micrometer (μm) range tends to result from combustion processes including electric generating technologies, while PM in the 10 μm range results from sources such as windblown dust or seasalt. Significantly, it is PM in the 2-5 μm and smaller range that health experts consider most harmful to humans because particles of this size can penetrate the body's natural defense mechanisms and reach most deeply into the lungs.

This project supports the PIER program objective of improving environmental and public health costs/risk of California's electricity by improving the scientific understanding of the PM10/PM2.5 problem in Northern California with an emphasis on quantification of emissions, the chemistry and physics involved in transport of PM, the formation and removal of PM10/PM2.5 and characterization of the meteorological conditions conducive to high PM 10/PM2.5 concentrations

PG&E and its subcontractor contribute to the multi-agency study by complementing the existing technical expertise with the rest of the participants in the Central California Study. This is done through PG&E involvement in technical and policy discussions; revising and providing comments on technical documents prepared for the study; participating in research activities culminating in technical papers presented at conferences; publication of technical papers; documentation of a field research program conducted in 1995; preparation of conceptual models for ozone and particulate matter formation in the central California region; and preparation of specific analyses such as the role of volatile organic compounds (VOC) in the formation of secondary ammonium nitrate in the San Joaquin Valley.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric Company (PG&E)

Contract amount: \$399,000

PG&E Project Manager: Samuel Altsbuler (925) 866-5879

CEC Project Manager: Guido Franco (916) 654-3940

† Project Title: Bird Strike Monitor

This goal of this project is to develop an efficient and cost-effective system to detect electric power-disrupting bird collisions with powerlines using a wire-trip mechanism. This system will provide power line owners with the tools necessary to identify the power lines responsible for multiple bird collisions, without spending time or money for unreliable and labor intensive reconnaissance. Once the power lines with high number of bird strikes are identified, powerline owners can then initiate mitigation strategies to reduce collisions. This project supports the PIER program objective of improving the environmental and public health costs/risk of California's electricity by providing information to reduce bird mortality associated with powerline collisions. This project also supports the PIER program objective of improving the reliability/quality of California's electricity by reducing bird-related power outages.

This project will continue development of an affordable, reliable, and proven device to detect bird collisions with electrical transmission and distribution wires. Bird strikes with power lines can result in temporary power outages. The Bird Strike Monitor can be used by all utilities and applicable regulatory agencies to identify and mitigate power lines responsible for multiple bird collisions. In areas that receive high use by migratory waterfowl, collisions with power lines can result in high bird mortalities, which is in violation of the Migratory Bird Treaty Act. Current methods used to identify lines responsible for killing birds and to determine actual numbers of bird mortalities are labor intensive and unreliable. Once the prototype has been deemed cost effective and reliable, design specifications of the Bird Strike Monitor will be documented sufficiently for manufacture.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$100,000

PG&E Project Manager: Sheila Byrne (925) 866-5987

CEC Project Manager: Linda Spiegel (916) 654-4703

Project Title: Avian Powerline Interaction

This project developed a course on reducing bird electrocutions and electric power-disruptions associated with bird collisions with powerlines as part of PG&E's involvement in the Avian Powerline Interaction Committee (APLIC). The APLIC is an internationally recognized organization dedicated to developing methods to mitigate the impact of powerlines on birds. This project supports the PIER program objectives of improving the environmental and public health costs/risk and reliability/quality of California's electricity by providing interested parties with information on how to reduce bird collisions with powerlines to prevent power outages resulting from these collisions.

This project supports PG&E's lead role in the APLIC and resulted in the presentation of a short course on preventing bird collisions and electrocutions. The short course, entitled, "Reducing Bird Collisions and Electrocutions" was held in May of 1998 at PG&E's Livermore Training Center.

The Commission's participation in APLIC provides an excellent forum for information exchange and research that results in increased compatibility of birds and electrical facilities by developing methods to mitigate bird collisions and electrocutions with powerlines. Approximately a dozen utilities, as well as the U.S. Fish and Wildlife Service and the Audubon Society, are members of APLIC.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$40,000

PG&E Project Manager: Sheila Byrne (925) 866-5887

CEC Contract Manager: Dick Anderson (916) 654-4166

Project Title: Wildlife Interactions with Utility Facilities

The goal of this project is to analyze products that reduce or prevent bird collisions, and resulting electrocutions and power outages, with powerlines and power facilities. Initially, this project will evaluate the durability and effectiveness of these devices. This project will also evaluate the applicability and effectiveness of a geographic information system (GIS) model that will allow Pacific Gas and Electric (PG&E) to plan future electrical facility upgrades that will reduce bird electrocutions and associated power outages. This project supports the PIER program objective of improving the environmental and public health costs/risk of California's electricity by improving current systems and technologies that prevent bird electrocutions caused by powerlines. This project also supports the PIER program objective of improving the reliability/quality of California's electricity by reducing bird-related power outages.

PG&E will conduct research to evaluate the durability of specialized add-on insulation products and perch deterrent products installed in the field to reduce wildlife electrocutions and resulting outages. Based on preliminary laboratory tests conducted by PG&E during 1996-97, some insulation products are susceptible to degradation caused by various environmental factors such as moisture, sunlight, contaminants, etc. Some materials deteriorated quickly in laboratory tests, and PG&E has recovered some products that have deteriorated in the field. This research will examine the condition of various products installed in the field and installation procedures, as appropriate.

In addition, research will be conducted to evaluate the usefulness of the geographic information system (GIS) model that incorporates the PG&E electrical distribution network and predictable wildlife resources to reduce the risk for wildlife electrocutions/collisions and outages on selected circuits. The GIS model was developed by PG&E in 1997 to aid in predicting areas susceptible to wildlife interactions. Electric planners and engineers believe a GIS

system could improve system reliability when used for planning new circuits or upgrading existing circuits. This research will evaluate the GIS system in selected PG&E Divisions to obtain data on its usefulness. The merits of this system will be shared with other utilities to determine its applicability outside the PG&E service area.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$130,000

PG&E Project Manager: Mark Dedon (925) 866-5829

CEC Contract Manager: Rick York (916) 654-3945

Project Title: Habitat and Species Protection

The goal of this project is to minimize raptor mortality (and resulting electric power disruptions) associated with power lines by identifying where and why this mortality occurs and then developing recommendations to minimize these impacts. Research will also be conducted to determine methods for minimizing the impacts of power facility construction on sensitive species and habitats. This project addresses the PIER program objective of improving the environmental and public health costs/risk of California's electricity by developing methods to minimize the environmental impact of power facilities on sensitive species and habitats. This project also supports the PIER program objective of improving the reliability/quality of California's electricity by reducing bird-related power outages.

ETS anticipates that raptor mortalities caused by electrocution at power lines will be reduced and power outages associated with such instances system-wide will be minimized. Consequently, raptors will be protected and power line system reliability will be improved.

In addition, multiple species habitat conservation research and habitat evaluation will be performed to develop protocols for characterization and monitoring of critical California habitat types to avoid or minimize impacts. Fewer habitat and species issues should arise because of the protocols developed by this research effort.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$525,000

ETS Project Manager: Dan Pearson (626) 302-9562

CEC Contract Manager: Marc Sazaki (916) 654-5061

Project Title: Trenchless Burial Equipment

The goal of this project is to develop three time- and cost-saving technologies that will allow utilities to construct and maintain underground electrical distribution facilities. Remote sensing and detection equipment will be developed that improves the utilities' ability to service existing underground facilities and improves the current underground tunnel boring technologies. This project supports the PIER program objective of improving the reliability/quality of California's electricity by developing technologies that will allow utilities to reduce power outages and minimize the impact of such outages when they occur.

This project will support the demonstration of three systems interrelated to underground distribution applications for improving systems reliability and lower costs to ratepayers. This project involves developing:

- a wireless fault indicator which would allow SDG&E crews to locate cable faults with a hand-held radio device rather than the conventional method of physically opening vaults to inspect fault switches;
- SafeNav, a device for detecting and avoiding underground obstacles before collision during boring; and
- digital imaging system designed to improve the productivity and safety during inspection and inventory of underground distribution facilities.

Contract Number: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$130,000

SDG&E Project manager: Al Figueroa (619) 654-8614

CEC Contract Manager: Ellie Townsend-Smith (916) 654-4170

† Project Title: Desert and Mountain Air Transport (DMAT)

The goal of this project is to develop and apply new methods for characterizing and quantifying the regional transport and chemistry of visibility-impairing emissions (haze) leading to improvements in regional visibility in California. (Haze refers to atmospheric moisture, dust, smoke and vapor suspended to form a partially opaque visual condition.) This project supports the PIER program objective of improving environmental and public health costs/risk by providing the knowledge of the transport and chemistry of visibility-impaired emissions to address the protection of visibility at mandatory federal Class-I areas in California and elsewhere.

The project will focus its efforts to:

- interpret inert tracer data released as part of the project to characterize the transport of emissions from various regions of the western United States;
- assess the reliability of currently available regional transport and chemistry visibility models; and
- develop “conceptual models” to provide a fundamental understanding of the transport and chemical mechanisms that cause western visibility impairment.

The modeling tools and methods developed under the DMAT Project will provide focus on the special visibility problems facing several Class I areas located in California as well as assist in developing assessment technologies for addressing the visibility problems facing urban areas of California.

The over-riding benefit of this project is to ensure that the most scientifically-sound environmental information is provided to the decision-making process in developing the most scientifically defensible, economically equitable, and cost-effective strategies for improving visibility specifically in California and more generally in the western United States. Air quality controls are the most costly of all environmental activities. The proposed new regulations for regional haze will potentially add significantly to these already high costs.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$825,000

ETS Project Manager: Vince Mirabella (626) 302-9748

CEC Contract Manager: Tuan Ngo (916) 654-3852

† Project Title: Water and Wastewater Electrotechnologies

The goal of this project is to develop and test electric, membrane and ultraviolet (UV) technologies that will help California municipalities reduce the energy costs of water and wastewater treatment. These technologies will allow municipalities to reduce their energy consumption while helping them maintain strict environmental and health standards. This project supports the PIER program objective of improving the energy cost/value of California's electricity by developing energy-efficient technologies that provide multiple environmental benefits.

This project will identify and develop technologies that will help local municipalities such as Metropolitan water District (MWD), Orange County Water District (OCWD) and Los Angeles County Sanitation District (LACSD) substantially reduce the cost of water and wastewater treatment. This customer segment represents approximately 10,000 water and wastewater Southern California Edison (SCE) customers that cumulatively consume over 1.9 billion kWh per year of electricity. In addition to being one of the most energy intensive industries, this customer segment has ever increasing restrictive environmental- and health-related regulations.

This project will:

- address Colorado River Water (CRW) salinity reduction measures;
- demonstrate the use of pulsed UV for disinfection and membrane biofouling control;
- investigate the formation and control of bromate during ozonation;
- study the disinfection of reclaimed wastewater with UV;

- evaluate the performance of low-pressure membranes; and
- provide commercial testing of nitrification and denitrification at LACSD's wastewater treatment plant.

Successful demonstration of this project will enable the water and wastewater customers to improve energy efficiency and cost effectively comply with environmental regulations.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$410,000

ETS Project Manager: Lory Larsen (626) 812-7598

CEC Contract manager: Wendell Bakken: (916) 654-4042

¹Project Title: Golden Eagles in a Perilous Landscape: Tracking the Effects of Mitigation for Energy-Based Mortality

The goal of this project is to assist in understanding the complex interactions of golden eagles and the electrical power producing Altamont Pass Wind Resource Area (WRA) structures. In the Altamont WRA, an estimated 40-60 golden eagles and several hundred red-tailed hawks are killed annually by collisions with wind turbines. Electrocution is another source of golden eagle fatality, both within and outside the WRA. These fatalities cause costly permitting delays and stakeholder concern.

This project supports the PIER program objective of reducing environmental costs/risk of California's electricity by providing critical information that may help reduce golden eagle fatalities in the Altamont Pass WRA. It also supports the PIER program objective of improving the reliability/quality of California's electricity by providing information that may overcome regulatory barriers to siting or replacing wind turbines in this area.

The work conducted under this contract will provide information focusing on whether the WRA-wide golden eagle population is stable, increasing in size or declining in size, and whether there is a correlation between golden

eagle use of the WRA and ground squirrel concentrations. This research will determine whether ground squirrel concentrations are attracting golden eagles into risky situations.

In addition, this project will document golden eagle use of the following areas: 1) where recent structural modifications have been made, 2) where wind turbines in high risk areas have been removed (determined by incidental carcass discoveries), and 3) where there has been repowering of some areas with new, larger, more efficient wind turbines. This research will aid in determining whether the new, larger turbines, their placement, and other existing turbine modifications, will reduce golden eagle fatalities. The work proposed in this project has the potential of greatly improving public perception of wind power because the net result of the industry's efforts to mitigate this issue can be directly measured.

Contract Number: 500-97-036

Contractor: Regents of the University of California Santa Cruz (UCSC)

Contract Amount: \$675,121

UCSC Project Manager: Grainger Hunt, (408) 459-2466

CEC Contract Manager: Dick Anderson, (916) 654-4166

¹Project Title: Electrotechnology Applications for Potable Water Production and Protection of the Environment

The goal of this project is to develop electrotechnologies which can produce new supplies of reliable and affordable drinking water, reduce electrical use to deliver and treat that water, and reduce the environmental problems created by current treatment and transport processes.

This project supports the PIER program objective of reducing environmental and public health costs/risk by possibly eliminating some conventional, chemically-intensive water treatment techniques and by helping to avoid transfers of water from environmentally sensitive

areas in northern California to southern California. It will also support the PIER program objective of impacting California's state and local economies by avoiding electricity use and costs to transport water over long distances and by avoiding investments in long-distance water transfer projects.

Edison Technology Solutions (ETS) will develop and test various electrotechnologies for potable water production and environmental protection. Six innovative electrotechnology-based water treatment processes will be evaluated by a consortium consisting of the Metropolitan Water District of Southern California (MWD), the Orange County Water District (OCWD) and the Electric Power Research Institute (EPRI) under the project management of ETS. The project consists of the following eight specific tasks:

- 1) Investigate advanced oxidation processes; 2) Evaluate biological denitrification; 3) Study solids removal technologies; 4) Assess salinity removal technologies; 5) Investigate disinfection alternatives; 6) Demonstrate solids processing techniques; 7) Perform energy and process assessment for system optimization; and 8) Investigate scale-up issues and provide technology transfer.

The research will be conducted to fully develop the potential of existing processes, such as membranes, while also investigating cutting-edge processes such as pulsed-ultraviolet radiation, carbon aerogel capacitive deionization and freeze-thaw conditioning. The three key agencies will be assisted by expertise from the University of California at Riverside, Lawrence Livermore National Laboratory, the American Water Works Association Research Foundation and a panel of the regions leading water and wastewater consultants. The approach of this project is to foster the development of emerging electrotechnologies with the intent to commercialize their applications on regional water projects.

Contract Number: 500-97-044

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$2,889,678 Match funding: \$13,936,359

ETS Project Manager: Lory Larson (626) 815-0520

CEC Contract Manager: Wendell Bakken (916) 654-4042

¹Project Title: Global Climate Change - California Implications and Potential Costs

The goal of this project is to study the phenomenon of climate change, and from the understanding gained, provide the information necessary to evaluate the best options for addressing the impacts of climate change in the U.S. including a focus on California. This project will improve our understanding of the potential physical impacts of global climate change in California and the impacts of efforts to reduce greenhouse gas emissions on the state's economy, the state energy system, and electricity production in particular.

This project supports the PIER program objective of reducing environmental and public health costs/risk of California's electricity by conducting research to support California energy policy initiatives and further research related to global climate change.

The purpose of this contract with the Electric Power Research Institute (EPRI) is to assess the potential costs and implications to California of global climate change. The assessment will make extensive use of the existing framework and expertise developed by EPRI and its subcontractors for similar studies conducted at the national and international levels.

The specific technical objectives upon which this project's success will be evaluated are:

- to reduce the uncertainty in, and improve the performance of, general circulation and carbon cycle models used to predict climate change effects
- to study the potential effects of climate change on human health, economic activities, and natural ecosystems;
- to evaluate regional impacts of possible climate changes, including potential effects in California on agriculture, forestry, and water resources. The project will also examine the economic implications

of proposed climate change mitigation policies as they could affect California, such as increasing prices for electricity and fuels; and

- to enhance an integrated assessment framework and use it to examine alternative proposals for reducing greenhouse gases in terms of costs and benefits.

Contract Number: 500-97-043

Contractor: Electric Power Research Institute (EPRI)

Contract Amount: \$2,159,800 Match funding: \$28,400,000

EPRI Project Manager: Richard Richels (650) 855-2602

CEC Contract Manager: Guido Franco (916) 654-3940

STRATEGIC ENERGY RESEARCH PROJECTS

Photo credit: Warren Greitz, Courtesy of NREL PIX



T Project Title: Dynamic Circuit Thermal Line Rating (DCTR)

The goal of this project is to develop improved estimates of conventional fixed normal and emergency electrical transmission line thermal ratings and demonstrate the feasibility of real-time transmission line ratings using dynamic thermal line ratings. This project supports the PIER program objective of improving the reliability/quality of California's electricity by providing more accurate rating of electrical transmission lines.

Transmission lines ratings have conventionally been established as a static rating, consisting of only one rating. The ratings of transmission lines are typically limited by allowable ground clearances and annealing (heating and slow cooling to strengthen and reduce brittleness) temperature of the conductor material. The amount of sag, and thus the rating, is actually determined by the convection cooling provided by environmental factors such as wind. By monitoring wind speed, conductor tension, and solar heating – it is possible to calculate a real time line rating. Real time line ratings are typically much higher than the static line rating. Also, at times of high ambient temperature and low wind conditions, it is possible that the real time line rating is less than the static rating, thus dynamic line ratings ensures safety by making sure that ground clearances are not exceeded.

DCTR uses equipment mounted on a transmission tower or pole to monitor the line conductor tension to determine sag and weather conditions to calculate the amount of current that can be transmitted. This information can then be provided to system operators or engineers for their use in operating the system and determining safe limitations for transferring system power.

Contract Number: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$110,000

SDG&E Project Manager: Bill Torre (619) 696-4880

CEC Contract Manager: Linda Davis (916) 654-3848

T Project Title: Electric System Seismic Safety and Reliability

The goal of this project is to develop methods and technologies that can be applied to reduce the earthquake vulnerability and improve the seismic reliability and safety of electric transmission and distribution systems. The greatest single natural-hazard threat to electric system reliability in California is the likely occurrence of a major urban earthquake. Post-earthquake functioning of utility systems, in particular electric power service, is viewed as vital for the state's rapid response to, and recovery from, a major earthquake. This project supports the PIER program objective of improving the reliability/quality and safety of California's electricity by providing essential information regarding the severity of damage to California's electrical infrastructure caused by earthquakes.

In 1996, Pacific Gas and Electric (PG&E) initiated a multi-year R&D program with the Pacific Earthquake Engineering Research Center (PEER) with the goal of helping the utility prepare for earthquake effects. The utility has identified and mitigated the most vulnerable facilities in high-hazard areas, but hazards and facility vulnerabilities exist about which PG&E is less certain. This research is being used to reduce those uncertainties and is focused on the following topical areas:

- Earthquake damage to porcelain insulators in high-voltage substation equipment has delayed restoring electric service following past earthquakes. To better understand the seismic performance of transformers and switches, researchers are using large-scale shaking tables to test and analyze these devices. From the results, improvements to installed equipment will be identified and tested, and the potential for future disruptions due to earthquake-induced damage can be reduced.
- Earthquakes cause significant damage to utility systems through strong ground shaking of facilities and by shaking-caused permanent ground deformation that damages building foundations. Researchers are working to develop improved

assessments of these hazards in formats that the utility can directly use for evaluating electric system vulnerabilities.

- In dense urban areas, the potential for fire ignited by electricity is perceived to be a significant safety threat. With input from PG&E specialists, PEER researchers are examining the process of fire initiation during power restoration following earthquakes to evaluate various means to reduce the risk of starting fires.
- Immediately following an earthquake, it is critical for emergency responders, including utility personnel, to learn as quickly as possible where an earthquake has occurred and how severe the shaking has been. PEER scientists are developing the capability to analyze data from distant seismographic instruments operated by academic institutions and the US Geological Survey to accurately predict the pattern and severity of strong earthquake shaking anywhere in the state. Coupled with data from local instruments, this capability will facilitate more effective emergency response to help save lives and more rapidly restore basic utility services.

Contract Number: 500-97-010

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$1,000,000

*PG&E Project Manager: William (Woody) Savage
(415) 973-3116*

CEC Contract Manager: Judy Grau (916) 654-4206

Project Title: System Stability and Reliability: Flexible AC Transmission Systems (FACTS) Benefits Study

The goal of this project is to investigate the feasibility of implementing Flexible AC Transmission System (FACTS) devices on Extra High Voltage (EHV) electricity transmission lines increase power transfer capability and electricity import capability. This project supports the PIER program objective of improving the reliability/quality of California's electricity by improving the efficiency of the power transfer capacity of the electricity transmission system.

This project will particularly focus on the benefits of existing and new FACTS devices for improving SDG&E's import capability. The impacts of FACTS, particularly on the SDG&E 230 kV transmission system located south of San Onofre, will be investigated. Existing FACTS devices resulted from previous SDG&E studies under contract with EPRI. The use of Static Condensers (STATCON), Thyristor Controlled Series Capacitors (TCSC) and Static Var Controllers (SVC) were examined in this previous study.

To meet the forecasted future electrical load in the SDG&E service area, either additional generation must be installed or import capability must be increased. FACTS help improve power transfer, power quality and system control. FACTS technologies, which use high-speed, thyristor-controlled devices and advanced control concepts, will allow loading lines to their thermal limits without compromising system reliability. The objective of this study is to conduct detailed technical and economic studies to investigate the benefits of FACTS technologies located in the SDG&E service territory.

Contract Number: 500-97-011

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$100,000

SDG&E Project Manager: Ali Yari (619) 696-2755

CEC Contract Manager: Linda Davis (916) 654-3848

Project Title: Phasor Measurement Units

The goal of this project is to develop a system that facilitates real-time monitoring of electricity transmission and distribution facilities. Low-cost sensors and software will be developed for use with a high-speed communication system that allows utilities and regulators to monitor the status of transmission and distribution lines. This project supports the PIER program objective of improving the reliability/quality of California's electricity by providing utilities and regulators with tools to monitor and maintain/support electrical transmission and distribution lines.

The purpose of this contract is to provide real-time monitoring and potential of future control of the Western Systems Coordinating Council (WSCC) electric power grid using Phasor Measurement Units (PMUs), which are low-cost sensors that measure voltage, current phase angles and magnitudes that are time tagged for relative comparison between different locations in WSCC. The data collected by the PMUs is communicated real-time to a Phasor Data Concentrator (PDC) at very high speed using communication systems from all the monitoring sites.

The system will allow various energy control centers and systems to monitor the entire WSCC system and will help to provide information to utility engineers for power-disturbance analysis purpose. The project will develop a system to pool data from all major WSCC members and make it available to all participating members. Two PMUs will be installed in Southern California Edison (SCE) with communication systems installed from these PMUs to the PDC. The data collected by the PMUs is communicated real-time to a Phasor Data Concentrator (PDC) at a very high speed using communication systems from all the monitoring sites.

In addition, software will also be developed, which will be used by the end users for viewing grid disturbance data and a system to communicate and pool data between the Bonneville Power Administration (BPA) PDC and SCE's PDC.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$150,000

ETS Project Manager: Mohan Kondragunta (626) 815-0507

CEC Contract Manager: Linda Davis (916) 654-3848

Project Title: USAT MOD-2

The goal of this project is to continue development of a satellite communication system offering high-data rate supervisory monitoring, control, and response to energy event-driven applications in regard to electrical transmission and distribution systems. The USAT Mod-2 satellite communications system is being developed to

deliver high-reliability communications for utility supervisory control and data acquisition (SCADA) systems of electrical transmission and distribution systems under all types of weather conditions. This project supports the PIER program objective of improving the reliability/quality of California's electricity by providing accurate electric grid monitoring information on power supply disruptions.

SCADA systems allow a utility to monitor and control its transmission and distribution system to insure high reliability. These systems require near-continuous communications, with updates from many locations delivered to the operator every few seconds. Traditionally, communications was accomplished by leased or private telephone lines, microwave, fiber optic cable or radio. The use of satellite communications has been shown to be very cost effective in remote areas, locations where other options are too costly, and as a backup for use during emergencies.

The USAT Mod-2 satellite communications system (also called ULTRANET™) is composed of a central satellite hub terminal connected to the SCADA master station and many, highly compact, remote satellite earth stations connected to substation monitoring and control equipment. The data is sent from the remote terminals to the hub through a geosynchronous satellite orbiting at 22,300 miles. The remote stations are rapidly installable (less than 15 minutes) and can be used during normal and emergency conditions, such as an earthquake, that could cause other communications systems to fail. High reliability and security of the communication system is obtained through the use of advanced spread spectrum technology.

The purpose of this project is to demonstrate fiber-optic level communication performance in remote areas, even in heavy rain conditions, at significantly lower cost. A low-cost hub is being developed to retrieve frequent status data and transmit control commands to remote substations. Previous work has developed the remote terminals that are located at the substations. This remote command and control ability in a substation can reduce O&M costs, improve power system reliability and reduce

customer minutes of interruption. The ULTRANET™ system can also be used for other applications outside of the utility industry to retrieve data such as stream flow, weather conditions, and seismic data.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$1,000,000

ETS Project Manager: Bob Yinger (626) 815-0508

CEC Contract Manager: Linda Davis (916) 654-3848

† Project Title: Energy Source Stabilizer (ESS)

The goal of this project is to develop an Energy Source Stabilizer (ESS) that functions through a generating machine governor or other electronics-controlled power device (i.e. battery energy storage systems, superconducting magnetic energy storage systems or high-voltage DC lines) to stabilize electrical frequency oscillations between various areas. This project supports the PIER program objective of improving the reliability/quality of California's electricity.

It is expected that ESS will stabilize these low frequency dynamic system oscillations by modulating the real power of generators, thereby improving system stability and reliability. System stability and power transfers from the northwest to California and from the east to Southern California are currently limited under stressed-system conditions. Control of these dynamic oscillations through the generating machine governors is more effective than the existing power system stabilizers that function through the generating machine excitation system. Once proven, the ESS units can be installed on all generating machines having state-of-the-art rapid response governors.

Two Energy Source Stabilizers will be installed at Alamitos Generating Station in southern California. ESS performance, during system disturbances, will be monitored to validate the working of ESS. In order to gain benefit of ESS, multiple ESS units need to be installed throughout the Western Systems Coordinating Council (WSCC) system. During this project, ETS will also conduct

a survey of WSCC utilities and power producers to identify the total potential locations for this technology installation in the future. It is estimated that the energy import capability into California can save the electronic customers approximately \$15-20 million per year.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$250,000

ETS Project Manager: Moban Kondragunta (626) 815-0507

CEC Contract Manager: Linda Davis (916) 654-3848

† Project Title: Substation Reliability

The goal of this project is to increase substation system efficiency, reliability and capacity and to reduce the operation and maintenance costs. This project supports the PIER program objective of improving the reliability/quality of California's electricity by providing electrical system operators a much quicker response time during transmission system breakup and disturbance.

To accomplish the project goals, an intelligent alarm analysis and diagnostics system that simplifies thousands of pieces of information and alarms during an emergency condition, such as a regional system breakup due to a fault, will be developed. In a matter of seconds, the operator is presented with only the relevant and highest priority information on system status and a recommended course of action. This compares to hours or days to do the same manually.

The second research activity is aimed at implementing voice data and command entry in control room consoles. There is an especially intense demand placed on operators during system disturbances when switching and other load and grid operations must be executed quickly and accurately. Speech recognition tools being adapted and evaluated will free the operator from the keyboard to permit data entry and commands by voice.

Contract Number: 500-97-012

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$215,000

ETS Project Manager: Alonso Rodrigues (626) 302-8423

CEC Contract Manager: Linda Davis (916) 654-3848

¹**Project Title: Laboratory-Type Facilities**

The goal of this project is to provide technologies and information that will improve the energy efficiency of laboratory-type facilities. Laboratory-type facilities, such as research laboratories, pharmaceutical laboratories, health-care facilities and manufacturing cleanrooms are an important segment of the California economy. Biomedical and electronics industries continue to lead in generating job growth and the food-products industry continues to be a mainstay in this area. A focus will be placed on the specialized ventilation, filtration and control equipment that consume a majority of the energy in these facilities. This project supports the PIER program objective of improving the energy cost/value of California's electricity by improving the energy-efficiency of an ever-growing sector of California's industry.

Collectively, laboratory-type facilities are estimated to account for 2 million kW (2 GW) of electric demand and almost 9 billion kWh (9,000 GWh) of electricity use annually (1993). This project continues field validation of design guidelines and design intent documentation; follows through with systems-oriented design tools for cleanrooms and data depository; and provides technology transfer through the project-developed information network. This project will accomplish its goal by:

- developing a new fume hood that reduces air flow requirements,
- developing a systems approach to air flow design criteria and tools that optimize fan power consumption,
- conducting field studies on HVAC technologies
- developing guidelines for energy-efficient laboratory design, and
- refining an existing computer-based analysis tool that facilitates a systems-oriented approach to clean room design.

Contract Number: 500-97-013

Contractor: California Institute of Energy Efficiency (CIEE)

Contract Amount: \$375,000

CIEE Project Manager: Karl Brown (510) 486-5338

CEC Contract Manager: Clint Lowell (916) 654-4554

²**Project Title: Development of a Real-Time Monitoring Dynamic Rating System for Overhead Lines**

The goal of this project is to increase the efficient use of overhead transmission lines by developing a monitoring system that provides instantaneous information to electric grid operators about monitored transmission lines' power-carrying capacity.

This project supports the PIER program objectives of improving the safety and the reliability/quality of California's electricity by providing a system to monitor transmission line-to-ground clearance thereby avoiding fires and electrical shock hazard and reducing power outages caused by sagging lines. The project also supports the PIER program objective of improving the energy cost/value of California's electricity by improving the efficiency and power carrying capability of monitored lines, thereby improving line utilization and reducing costs of power delivery and reducing losses.

This project will develop and demonstrate a system for real-time monitoring of conductor clearances/sags in power lines. The capacity of many existing electric transmission lines is limited by conductor performance at high temperatures, i.e., exceeding the minimum ground clearances (the minimum allowable distance between the conductors and the terrain directly below the line) because of increases in sag with increased temperature or annealing of the aluminum. Because utilities do not have an accurate real-time measure of ground clearances along the length of transmission lines, they are constrained to use very conservative assumptions to not violate safety code requirements. In taking this necessary approach, many amps of capacity that could be utilized if ground clearance/sags could be quantified on a real-time basis are lost. It is estimated that 20 percent of the transmission lines in California have excess capacity inherent in their

designs that could be utilized if a real-time monitoring dynamic rating system for overhead lines was available.

A system with sensors for monitoring ground clearances/sags in selected spans on a real-time basis coupled with software to model the clearances/sags in all spans is needed to enable utilities to confidently operate many lines at higher temperatures without exceeding code-specified clearances. Such a system will enable more efficient utilization of existing lines during normal operations, and will increase the overall reliability of grid operations by enabling better utilization of alternative load paths during emergency operations. A peripheral benefit is that such a system could be used to monitor the status of critical spans in lines where safety is of particular concern, e.g. highway crossings, crossings over navigable waters, etc.

Contract Number: 500-98-034

Contractor: Engineering Data Management, Inc (EDM)

Contract Amount: \$499,402 Match funding: \$510,019

EDM Project Manager: Andrew H. Stewart (970) 204-4001

CEC Contract Manager: Linda Davis (916) 654-3848

²Project Title: Development of a Composite Reinforced Aluminum Conductor

The goal of this project is to improve the reliability and capability of California's electrical transmission and distribution system by developing a stronger and lighter conductor to replace aging and overloaded power lines. Many miles of California's overhead electricity transmission lines have reached the end of their service lives or are being stressed beyond their design limits due to load growth and heavy power transfers across longer distances. Specifically, this project will develop a composite reinforced aluminum conductor (CRAC) to replace conventional conductors made from aluminum wires wrapped over a core of steel strands (called aluminum conductor—steel reinforced (ACSR) conductors).

This project supports the PIER program objective of improving the reliability/quality of California's electrical system by developing an electrical conductor which is

better able to withstand adverse weather and high-load conditions, thereby avoiding power outages caused by line sagging and swinging, high winds, and ice build-up on power lines. It also supports the PIER program objective of improving the energy cost/value of California's electricity by reducing the costs of reconductoring. Specifically, new transmission lines made of CRAC carry more electrical current than comparably sized ACSR conductors, so support towers do not need rebuilding to accommodate heavier, equivalent-capacity conventional conductors.

Composites (reinforced-resin materials) are strong, lightweight and corrosion resistant, but manufacturing costs for electrical conductor applications have been too high to be market competitive. However, a new, integrated design and manufacturing development is making CRAC technically and economically feasible.

W. Brandt Goldsworthy and Associates, Inc. of Torrance, CA, with additional match-funding support from the Los Angeles Regional Technology Alliance (LARTA), is reconfiguring aluminum conductors around a lightweight composite strength member whose weight is approximately 25 percent of the traditional steel strength member. The resulting lightweight conductor can be optimized for reduced sag and increased ampacity. CRAC conductors can withstand adverse weather and high load conditions, thereby avoiding power outages caused by line sagging and swinging, high winds and ice buildup. This technical development is very timely as the current age of transmission lines ranges from 30 – 70 years. The target price for CRAC is \$1.00 per product pound, which is approximately the cost of aluminum conductors which are steel reinforced.

Contract Number: 500-98-035

Contractor: W. Brandt Goldsworthy & Associates, Inc.

Contract Amount: \$75,000 Match funding: \$185,000

Contract Project Manager: W. Brandt Goldsworthy (310) 375-4565

CEC Contract Manager: Linda Davis (916) 654-3848

²**Project Title: 2 kWhr Flywheel Energy Storage System**

The goal of this project is to demonstrate a two-kWhr flywheel energy storage system for distributed generation and load shifting that will be directly scaleable to ten kWhr. The technical objective of this project is the design, fabrication and operation of a cost-effective composite flywheel having emphasis upon both high specific energy and low idling losses. This project supports the PIER project objective of improving the reliability/ quality of California's electricity by providing a load shifting technology that can be used during peak load periods.

Technical barriers to flywheel development have largely been overcome. However, the technology can be improved by developing a passive magnetic bearing that is fully optimized with respect to low losses, lower cost, simplicity, low maintenance and function. Incremental improvements in composite rotor design will also permit advances in specific energy performance. In addition, economic barriers such as the high cost of the graphite fiber and advanced permanent magnets used in the Flywheel Storage System will be addressed.

Development, assembly and testing of the 2 kWhr flywheel will be performed at Trinity's Engineering Center in Livermore, California. The project will be performed over a two-year period culminating in a field demonstration of the flywheel at a residential site in California. The prototype used for the field demonstration will complete the transition from further development of the technology to volume manufacturing after any slight modifications suggested by the field test data are incorporated into the new, modified design.

Contract Number: 500-98-036

Contractor: Trinity Flywheel Power

Contract Amount: \$1,057,406 Match funding: \$1,062,494

Trinity Flywheel Power Project Manager: John Eastwood (415) 362-0634

CEC Contract Manager: Jamie Patterson (916) 654-4819

²**Project Title: Light-Activated Surge Protection Thyristor for Distribution System Reliability**

The goal of this project is to design and build a prototype light-activated surge protection thyristor (LASPT) with a high-current capacity that will increase electrical distribution system reliability by preventing surge-initiated cascading electrical failures. The specific goal of this project is to develop a prototype LASPT with a current (dI/dt) of greater than 10,000 Amps/microsecond (A/ μ s) to increase electrical distribution system reliability. This project supports the PIER program objective of improving the reliability/quality of California's electricity by increasing electric distribution system reliability.

To realize the overall goal stated above, two technological objectives must be achieved. The first scientific objective is to design a multiple fiber optic coupling for the activation of large area semiconductors. Given recent advances in sol-gel bonding materials and material grooving techniques, the Contractor plans to conduct the electronic industry's first demonstration of a large area semiconductor activation with laser light. This will have a significant impact on all future semiconductor photoconductive switching. The second engineering objective of the project is to design and fabricate a functional electrical utility device using the newly developed optical coupling. The resultant LASPT will have a surge response rate of 10,000 amps per microsecond and a peak current of greater than 15,000 amps at a voltage rating of 3,000 volts.

With respect to performance objectives, the LASPT project's prime benefit lies in its ability to increase California's electric system reliability by reducing the damaging effects (both in terms of severity and frequency) of power transients caused by lightning strikes, switching surges, power line faults and equipment malfunctions. A second benefit, flowing directly from the first, is a reduction in California's electricity rates. When the damaging effects of power transients are reduced, so, in turn, is the cost of

replacement power, which is normally passed on to all users when power line faults occur. Based on EPRI's 1997 estimates of \$1 billion losses per year, annual savings can be estimated to range from \$60M - \$110M per year.

Contract Number: 500-98-038

Contractor: Energy Compression Research Corporation (ECRC)

Contract Amount: \$494,239 Match funding: \$93,292

ECRC Project Manager: David M. Giorgi (619) 450-6612

Commission Contract Manager: Jon D. Edwards at (916) 654-4851

²Project Title: Sagging Line Mitigator (SLiM)

The goal of this project is to develop and test a sagging line mitigator to automatically counteract the sagging of high voltage electrical transmission lines due to high ambient temperature and electric current flow. The specific goal is to develop the SLiM device from basic principles to market readiness. This project supports the PIER program objective of improving the reliability/quality of California's electricity by improving transmission system efficiency and reliability by counteracting the effect of temperature on the sagging of overhead transmission lines, leading to increased line load current capacity.

Specific objectives of the project include:

- complete design and analysis work for the proposed SLiM device;
- conduct rigorous prototype testing for applicability, proof-of concept and design refinement;
- develop manufacturing and marketing plans for introduction of the SLiM device into the market;
- production of the SLiM device; and
- sales and support of the SLiM device to the electric power transmission industry.

The product to be developed has the potential to revolutionize treatment of overhead transmission lines for both retrofitting of existing lines and construction of new lines. It will significantly reduce the risk of forest fires and

brownouts caused by sagging lines, increases the efficiency of energy transfer, delays the need for additional line capacity and delays the construction of new lines. Used on new lines, this product will allow reduced tower height and/or increased distance between towers.

Contract Number: 500-98-042

Contractor: Materials Integrity Solutions, Inc. (MIS)

Contract Amount: \$900,000 Match funding: \$304,833

MIS Project Manager: Manuchebr Shiromohamadi (510) 594-0300

Commission Contract Manager: Jon D. Edwards at (916) 654-4851

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Dr. Richard E. Balzhiser

retired as President and Chief Executive Officer of the Electric Power Research Institute (EPRI) in Palo Alto, California in August 1996. He remains active in a President Emeritus role at EPRI in addition to serving on several industry boards and technical advisory committees. Dr. Balzhiser currently serves a variety of boards and committees including the Energy Subcommittee of the President's Council of Advisors on Science and Technology, the Woods Hole Oceanographic Institution Advisory Board, the Pacific Northwest Laboratory Advisory Committee, and the Technical Advisory Board of the Massachusetts Institute of Technology Energy Laboratory.

Dr. Patricia A. Buffler

is Dean Emerita and Professor of Epidemiology and Public Health at the School of Public Health, University of California, Berkeley. Dr. Buffler's research interests include epidemiology of childhood leukemia and health effects of non-ionizing radiation, environmental tobacco smoke and exposure to hazardous waste sites. She serves on the Board of Directors, U. S.-Japan Radiation Effects Research Foundation, Hiroshima, Japan; the World Health Organization, Expert Advisory Panel on Occupational Health; the U. S. Environmental Protection Agency Science Advisory Board; the U. S. Public Health Service Centers for Disease Control and Prevention, Task Force on Community Preventive Services; and the National Institutes of Health, National Advisory Council on Environmental Health Sciences.

Dr Linda R. Cohen

is Professor and Chair for the Department of Economics at the University of California, Irvine. Her fields of study are political economy, government regulation, government policy for science and technology, and positive political theory and law. Dr. Cohen has advised numerous federal departments and agencies on science policies, including the Departments of Energy and Commerce, the Office of Technology Assessment and the Congressional Research Service and has served on several committees for the National Research Council. She has testified before state agencies and commissions, including the California Energy Commission and the California Constitutional Reform Commission

Members of the Independent PIER Evaluation Panel

Dr. John S. Foster Jr.

is a retired Vice President of Science and Technology of TRW Inc. and former chairman of the Defense Science Board. Dr. Foster is currently Chairman of the Board of Directors of Pilkington Aerospace, chairman of Technology Strategies and Alliances, and consultant to TRW, United Technologies Corporation and Defense Group, Inc. His field of specialization is Industrial Manufacturing and Operating Systems Engineering and he is recognized for his work in technological leadership in defense research and engineering. Dr. Foster was the director for the Lawrence Livermore National Laboratory from 1961 to 1965. In 1965, Dr. Foster left the Lab for Washington and became Director of Defense Research and Engineering.

Dr. T. Kenneth Fowler

is retired Professor of the Graduate School, University of California, Berkeley. Dr. Fowler helped establish the multi-disciplinary Center for Nuclear and Toxic Waste Management at UC Berkeley. His honors and awards include elected membership in the National Academy of Sciences; Fusion Power Associates Distinguished Career Award, 1995; and The Berkeley Citation, 1995. Dr. Fowler's areas of interest include energy research funding and the appropriate role of government in anticipating problems of energy-associated pollution and energy-associated competition for resources in its research funding policies.

Fred W. Kittler

is co-founder and principal owner of Velocity Capital Management, an investment firm based in Palo Alto that provides equity funding for public and private technology and communications companies. Mr. Kittler was a research analyst and portfolio manager for J. P. Morgan Investment Management where he managed an \$800 million portfolio of small technology and health science company stocks. He serves on the Visiting Committee On Advanced Technology for the National Institute for Standards and Technology, and previously established a foundation, Connections for Learning, to promote the use of computer networks for K-12 education in the New York area.

Peter M. Miller

is a scientist with the Natural Resources Defense Council, Inc., a nonprofit national environmental organization. He is part of NRDC's energy project, which promotes the increased development of energy efficiency and other environmentally sound and cost-effective energy resources. His work involves research, analysis, and advocacy at the state, national, and international levels. He has participated in utility advisory committees in California, Hawaii, and the Pacific Northwest, in numerous proceedings before the California Energy Commission, the California Public Utilities Commission and the Northwest Power Planning Council, and in rulemakings before the U.S. Department of Energy. He was appointed to the California Board for Energy Efficiency in April 1997.

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Dr. Esteban Soriano

established his own market research and program assessment company (The Resource Group), specializing in educational and economic assessments. He currently serves as Vice President for University Advancement at California State Polytechnic University, Pomona. He is an expert in communication strategies, economic impact studies and assessments, methodology and research design, and has extensive experience relating to electric and water utilities.

Dr. James L. Sweeney

is Professor and Chair for the Department of Engineering-Economic Systems and Operations Research, Stanford University. Dr. Sweeney has 25 plus years of experience working in energy and environmental economic issues, having worked at the federal level in the Federal Energy Administration in the 1970's, to a long history of research and analysis in energy economics and technology issues. Dr. Sweeney has had inputs into a number of National Energy Plans, is a member of the National Research Council, and has been president of the International Association for Energy Economics.

Dr. Mary L. Walshok

is Associate Vice Chancellor - Extended Studies and Public Programs and Adjunct Professor in the Department of Sociology at the University of California, San Diego. She is the recipient of many awards and honors, among them a Kellogg Foundation national fellowship. Dr. Walshok serves on the board of the California Council for the Humanities and is a member of Governor Wilson's Economic Strategies Panel. She also is a member of numerous community boards and professional associations including the San Diego Community Foundation, Girard Foundation, Eureka Communities, Foundation for Enterprise Development and ACCION.

Carl J. Weinberg

is currently a private consultant after retiring from Pacific Gas and Electric Company where he worked for almost 20 years including eight years as Manager of Research and Development. Mr. Weinberg has been a contributor to the development and implementation of corporate, industry and national energy policies and strategies through research program management. He has extensive understanding of energy technologies, including commercial and potential renewable and conservation technologies, and has demonstrated effectiveness at accelerating technology readiness and proving technology benefits.

